ISBN 0-7743-9962-7

THE PHASE 1 REPORT OF THE AUDIT OF THE ACIDIC PRECIPITATION IN ONTARIO STUDY MONITORING NETWORK

ARB - 228 - 84 - ARSP

Prepared for:

Ministry of the Environment
Air Resources Branch
880 Bay Street, 4th Floor
Toronto, Ontario
M5S 1Z8

by

Concord Scientific Corporation
2 Tippett Road
Downsview, Ontario
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AR42-12

Concord Scientific Corporation

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VOLUME I

CSC 110.J348.2

Submitted to

APIOS QA Co-ordinator
Air Resources Branch
Ministry of the Environment
880 Bay Street
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ACKNOWLEDGEMENTS

The authors would like to express their appreciation to all members of the APIOS programme for their assistance during the audits. In particular we would like to thank Messrs. W. Bardswick, R. Kirk, S. Elliot, D. Allcock, J.P. Varto, and C. Hutt for their valuable contributions and co-operation throughout the programme.

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1. INTRODUCTION

Concord Scientific Corporation (CSC) has been contracted by the Ministry of the Environment (MOE) to carry out two audits of the Acidic Precipitation Ontario Study (APIOS) monitoring programme (laboratory activites were requested by APIOS personnel not to be included in the audit as it had been addressed in a previous audit). The Phase I audit was carried out during the fall of 1983 and the winter of 1984 and the Phase II Audit will be carried out during the summer of 1984. As described in Concord's proposal (Concord Scientific Corporation 1983a) at the end of the first phase the findings of the audit would be presented in the Phase I Report to the APIOS QA Co-ordinator.

This report contains the findings of the Phase I audit (in this report the Phase I audit will often be referred to as "the audit") including any recommendations regarding changes to the APIOS programme. Volume I of this report is broken down into four main chapters. The first chapter is a summary of the audit pointing out the major weaknesses and strengths of the programme are. The second chapter is dedicated to performance related audit findings. These findings are a quantitative and qualitative measure of how well the APIOS procedures are being carried out. The third chapter on system related audit findings details where modifications might be made to areas of the programme (documentation, sampling protocol etc.) to better meet the overall network objectives and requirements of the APIOS Quality

Assurance Plan (Bardswick 1983b). The last chapter is a summary of all the recommendations described throughout the report.

Volume II of the Phase I Audit Report contains the completed Phase I site audit questionnaires that were prepared by CSC's auditors with accompanying photographs of the individual audited sites.

2. SUMMARY

The objective of the Phase I Audit was to assess how various components (laboratory activites excluded) within the APIOS programme are contributing to the production of "high quality" data. This involved determining the effects of these components on data accuracy, precision, comparability, completeness and representativeness. As part of this objective, the strengths and weaknesses of the programme were identified and, where appropriate, recommendations made regarding changes to the existing programme.

As described in Concord Scientific's Proposal (Concord Scientific Corporation, 1983a), before carrying out the Phase I Audit, an Audit Design Plan was prepared (Concord Scientific Corporation, 1983b), detailing the tasks to be carried out. It also contained a review of the 1982 audit recommendations (further necessary action on these recommendations are described in Section 4.10 of this report), and a review of the recently completed APIOS Quality Assurance Plan (Bardswick 1983b). While the Audit Design Plan review of the APIOS QA Plan noted some areas where improvements could be made, in general, APIOS's QA Plan provides a strong framework for the programme's quality assurance activities.

The findings of the Phase I audit indicate that APIOS, for the most part, is properly executing the procedures that are contained

in a recently prepared Technical and Operating Manual (Bardswick 1983a).

Marked improvements since the 1982 audit were noticed in the areas of network documentation, data validation and the implementation of additional QC routine procedures. These improvements are a result of the preparation and distribution of the Technical and Operating Manual, APIOS QA plan and Data Validation Procedures.

The findings of Phase I indicate that APIOS, for the most part, is executing the procedures that are contained in the APIOS Technical and Operating Manual (Bardswick, 1983a). The technologists' performance was within the requirement of the collection of good data. Their relationship with site operators, ability to think and work independantly and solve problems while in the field make them one of the real strengths of the APIOS programme. The findings of the audit indicate that operators, for the most part, are interested in the monitoring programme and maintain a positive attitude; however, most do need updated procedures training. Technologists also require updating on some monitoring activities to ensure that the most current procedures are being carried out. This updating will help to assure that the APIOS field programme continues to be properly executed.

Some of the monitoring sites visited during the audit when evaluated against APIOS siting criteria, current APIOS operating

procedures and instrumentation operating specifications are free of any major effects that would adversely affect sample integrity. The other sites, however (see Section 3.1), should be reviewed by the APIOS QA Co-ordinator, as they are either violating the siting criteria or the operator's handling procedures may be jeopardizing sample integrity. Some of these sites require immediate corrective action, while for others they should be reviewed for there is a potential for adverse effects on data quality.

The turnaround time for data from field sheet to published report has improved, but, in some areas (cumulative Low Vol dry deposition sampling), is still fairly slow. The computerized data validation procedures have been well developed for most of the monitoring activities, but there is still a need for more manual screening of the data to detect problems and initiate corrective action as soon as possible and to quantify data precision and accuracy.

The forthcoming APIOS QA Manual mentioned earlier should be prepared as soon as possible, as it will bring together all the various quality assurance procedures currently being carried out (eg. co-located sampling, calibration, blind samples). This Manual will show how these procedures fit together in the quality assurance system, so that estimates of data accuracy, precision, completeness, comparability and representativeness can be made, and will also outline various procedures for the detection and prevention of problems within the

network. It will also describe QA activities that have not yet been incorporated into the operating system, such as internal audits, corrective action and procurement control. With the completion of this document, the full APIOS quality assurance programme can become operational.

Finally, in carrying out an external audit of network operations, there are two factors over which the auditor has no control. The first is that findings of an audit are a "snapshot" of what is presently occurring in the network. Past and future events are taken into account where possible when the auditor visits a site, talks to a technologist, or looks at a set of data, but the auditor bases his or her evaluation on what is presently occurring, not on what was happening six months ago or on possible future changes. The second factor is that, although the auditor makes use of all the network's available information, he or she cannot identify all of the institutional and logistical constraints that are imposed on APIOS. These two factors may render some of the criticisms, comments and recommendations included in this report inapplicable or unreasonable.

3. PERFORMANCE RELATED AUDIT FINDINGS

The performance related audit procedures include site audits, technologist audits and data handling and validation audit. The performance audit's purpose was to determine how well the sites, technologists and data processing procedures were in agreement with the documented APIOS procedures and to quantify network performance.

The results of all three types of audits mentioned above show improvement over the results of the 1982 audit. The auditors believe that this can be largely attributed to the thorough documentation and following of procedures used by the various personnel within the programme. There are, as always, areas where improvement can be made especially in the areas of training up-grade and manual data screening. The performance related findings will be discussed in the following sections under, site, technologist and data along with any appropriate recommendations. A summary of all recommendations from these findings may be found in Chapter 5.

3.1 Status of Monitoring Sites

During November and December of 1983 a total of thirteen sites were visited (see Table 3.1.1) as part of the audit. The sites were audited for their representativeness, the site operators for their ability to correctly carry out sample handling procedures and the on-

TABLE 3.1.1

Sites Visited During the 1983 Site Audits

SITE	TYPE OF SITE
Longwoods	Event Wet/Dry
Melbourne	Event Wet
Alvinston	Cummulative
Shallow Lake	Cumulative
Mattawa	Cumulative
Azure Lake	Cumulative
Moonbeam	Cumulative
McKellar	Cumulative
Nithgrove	Event Wet
Campbellford	Cumulative
Graham Lake	Event Wet
Golden Lake	Cumulative
Colchester	Cumulative

site instrumentation for its ability to operate within an acceptable specification range. The criteria or procedures that the sites, instruments and operators were audited against can, for the most part, be found in the APIOS Technical and Operating Manual (Bardswick, 1983a). The site audits were designed where possible, to be similar to the previous 1982 site audits so that the 1982 and 1983 audit results could be compared.

In general the site auditing procedure was quite successful, however at two sites (Graham Lake, McKellar) although repeated attempts were made, the operator was unavailable at the time of the site visit. At a few other sites adverse weather conditions prevented the full range of instrument checks from being carried out (eg. freezing rain during Campbellford site visit). Most of the site audits were carried out during wintertime conditions. Although at times this made the auditor's job quite difficult due to the full range of site, operator and instrumentation checks carried out during the site audits, it also exposed problems that would not normally be present during fair weather conditions.

The questionnaires used during the audit are shown in Appendix I. They were modified since the 1982 audit to reflect changes in the APIOS siting criteria and operating procedures (Bardswick, 1983a) and to improve their usefulness during site audits. The purpose of the questionnaires was to audit the site's representativeness, operator

performance and instrument performance. The auditor's completed questionnaires, site photographs and aerial photographs of the site and surrounding areas for each of the sites audited are shown under separate cover in Volume II of this report. Sources of information, along with items to be considered when completing the questionnaires are also contained in Volume II.

After the site audit information on the operator, on-site instrumentation and the site itself had been documented, a summary including advantages and disadvantages and required corrective action from the audit findings on the site, operator and instrumentation was prepared. These summaries are included in Appendix II. What should be remembered when reviewing the site audit questionnaires or summaries is that during an external audit information gathered during the site visit is a "snapshot" of what is observed at the site at the time of the visit and sometimes may not fully represent what takes place (e.g., sample handling, instrument checks) at the site on a day-to-day basis. Results of regional technician's periodic internal audits of the sites they are responsible for should be compared by the QA Co-ordinator to the results of the external audit carried out by CSC, to determine if both sets of findings are consistent.

One of the documented APIOS Quality Assurance procedures involves the regional technologists giving a subjective evaluation of the sites they are responsible for and applying a rating, ranging from

Excellent to Poor. In order to be comparable the same range of ratings was used by Concord Scientific Corporation in evaluating sites. Two ratings were given, one for siting related components and one for operation related components. These components used in reporting the Audit Findings (Table 3.1.2) in determining the ratings are described below:

SITING

a) Windbreak

- for how many degrees of the compass is there a windbreak and what type of trees make up the windbreak? (deciduous, coniferous, mixed)
- the ideal case is 360° of coniferous windbreak

b) Ground Cover

- good ground cover is cut grass or moss
- poor ground cover is exposed soil
- no object within 5 metres of the sampler that is above the height of the sampler.

c) Obstructions

- no object should be within 2.5 time object height to the sampler or be above the level of sampler orifice

d) Representative Topography

- the topography and vegetative ground cover should be representative of the surrounding area (50 km)

e) Roads/Transportation

- no major transporation line (road/railway) within one kilometre of the site which might be a contamination source

f) Agriculture

- no agriculture which might provide a contamination source within one kilometre of the site.

g) Towns/Cities

- no urbanized areas close to the sampling site (distance depends on size of town/city).

h) Pollution Sources

- no minor pollution sources within one kilometre (eg. sewage lagoons, salt and sand piles, gravel pits, exposed fields, etc.)
- no major pollution sources within fifty kilometres (eg. power plants, smelters, saw mills, pulp and paper plants, etc.)

i) Power Failures

- how many power failures are there per year (only an important factor if failures interfere with sample collection or integrity)?

j) Deviations

- what are the major deviations of the site from the APIOS siting criteria?

k) Advantages

- what were the major advantages of the site?

l) Rating

- objective evaluation based on findings from items a to k above.

OPERATIONS

a) Condition of Instrument

- tests and observations carried out during the site audit to determine how well the instrumentation has been performing prior to the site visit and during the site. This information which may be supplied by the operator or by observations during the site visit (dirty gaskets or sensor, precipitation in the

dry side of the sampler) indicates past and present performance.

b) Understanding

- by the operator of procedures. Has he read the APIOS manual, does he understand it, does he understand the sampling protocol?

c) Following Protocols

- the auditor checks to see if the operator checks the instrument performance regularly, handles the sample as per protocol, cleans the required components properly (knife edge, gasket), stores the sample in a location that would prevent sample degradation and follows only updated sampling protocol.

d) Attitude

- of the operator towards the procedures that he or she must follow and towards the APIOS programme in general.

e) Reaction to Problems

- does the operator get in touch with the regional technologist promptly if a problem is noted?

f) Submission Forms

- does the operator properly and completely fill out the sample submission forms?

g) Retraining Needed

- is the operator following the most current operator procedures?

h) Deviations

- by the operator from current APIOS operator sampling protocol.

i) Advantages

- of the site operation

j) Rating

- objective evaluation based on the findings from items a to i above.

A summary of the audit findings of the siting and operations components along with their ratings for each site (rating scale - excellent, good, reasonable, marginal, poor) is shown in Table 3.1.2. A summary of the siting and operator ratings for all audited sites is shown in Table 3.1.3. This table is a good method for presenting site ratings for it shows for which sites corrective action should be taken.

As was described in the APIOS QA Plan (Bardswick 1983b) a rating of marginal or poor requires that the QA co-ordinator review the site and make changes to improve the rating or re-locate the site. A marginal rating is an alert that potential problems exist. A poor rating indicates that changes should be made immediately. Table 3.1.2 should be helpful in determining which components contribute to a lower rating and in consultation with the regional technologists corrective action can be taken. The auditors suggested corrective action requirements for each audited site are included in the site audit summaries in Appendix II.

As can be seen from Table 3.1.3 some of the sites that have lower ratings can be upgraded with changes to the site or operator (Melbourne, Alvinston, Longwoods, Mattawa, Campbellford). Two sites should be reviewed immediately by the QA Co-ordinator and corrective action taken to prevent poor data from being collected. These are:

Colchester - due to its location, in town, on Lake Erie and the exposed nature of the area, this site should be reconsidered.

Moonbeam - both the site and operator probably provide sources of contamination to the sample.

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	1. ALVINSTON	2. GOLDEN LAKE
I SITING		
(a) Windbreak	270° (deciduous)	270° (mixed)
(b) Ground Cover	Good	Good
(c) Obstructions	Yes (many trees & bushes)	Yes (many trees)
(d) Repres. Topography	Yes	Yes
(e) Roads/Transp.	Park Road (Seasonal use 40 m)	Road (paved 300 m)
(f) Agriculture	Yes (But rep. of area), 100 m	No
(g) Towns/Cities	Yes (5 km to Alvinston, pop. 600)	No
(h) Pollution Sources	No	No
(i) Power Failures	Several (breakers the cause) (at least 1 long term example)	2-4/year main line for minutes only
(j) Deviations	Trees <2.5 H, Agriculture, Road Downslope	Obstructions (trees)
(k) Advantages	Remote, Representative	Remote, Representative
(l) Rating	Marginal, but requires immediate modification	Excellent, but requires immediate modification
II OPERATIONS		
(a) Condition of Instr. - Present	Down (up to 1 week)	Resist. low, clutch too tight, off-level
- Past	Resist. low; land not cleared Reg.	Same as above only
(b) Understanding - Has manual	Yes	Yes (portions)
- Read manual	Yes	Yes
- Understands protocol	No	Yes
(c) Following Protocol - Instr. Checks	No	Yes
- Sample Handling	No (1 pair of gloves only, bag edges turned in)	No (no gloves but good technique), reasonable
- Cleaning	No (only knife edge)	No (only knife edge and gasket), reasonable
- Storage (Sample)	Yes	Yes
- Std. Gauge Protocol	No (old protocol)	Yes (new protocol)
(d) Attitude	Good	Excellent
(e) Reaction to Problems	Good	Yes - Excellent
(f) Submission Forms	Good	Yes - Good
(g) Retraining Needed	Yes	Yes - gloves (minor)
(h) Deviations	Not following protocol	No
(i) Advantages		
(j) Rating	Marginal (requires upgrading)	Excellent (upgrading re gloves)

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	3. CAMPBELLFORD	4. AZURE LAKE
I SITING		
(a) Windbreak	180° (mainly deciduous)	180° (coniferous)
(b) Ground Cover	Good	Good
(c) Obstructions	No	Yes (1 tree & building)
(d) Repres. Topography	Yes	Yes
(e) Roads/Transp.	Yes (500 m - reasonable)	Road (200 m, limited use, sep. by trees), Gravel parking lot
(f) Agriculture	Yes (Farm 0.5 km away)	No
(g) Towns/Cities	Yes (pop. 4000 < 2 km)	No
(h) Pollution Sources	No	No
(i) Power Failures	Unknown	Unknown
(j) Deviations	Road, open, farms, town	No tel., obstr., building snow blowoff
(k) Advantages	Remote, representative	Remote, limited road use
(l) Rating	Marginal (town)	Good (cut tree, building snow blowoff of concern)
II OPERATIONS		
(a) Condition of Instr. - Present	Non-operative	Poor (no Lovol also)
- Past	Unknown (testing not possible)	N/A - new site
(b) Understanding - Has manual	Yes (partial)	Yes
- Read manual	Yes	No
- Understand protocol	Yes	Yes
(c) Following Protocol - Instr. Checks	No (interim checks 2-3 times/4 weeks)	Yes
- Sample Handling	Yes (but glove only on r. hand)	Yes (but used dirty glove in bag)
- Cleaning	Yes (only gasket & knife edge)	Yes (uses DI in winter)
- Storage (Sample)	Yes (garage)	Yes (refrig)
- Std. Gauge Protocol	No (no temp. in winter)	Using new protocol with old gauge
(d) Attitude	Good	Excellent
(e) Reaction to Problems	Good	Slow (no telephone)
(f) Submission Forms	Good	Good
(g) Retraining Needed	Yes (had not been told to follow winter protocol)	Yes (limited)
(h) Deviations	Gloves, winter protocol	Minor
(i) Advantages	Attitude, conscientious	Well read, interested
(j) Rating	Good (needs upgrading to winter)	Reasonable, needs upgrading

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	5. MOONBEAM	6. MATTAWA
I SITING		
(a) Windbreak	Nil	~180° (coniferous)
(b) Ground Cover	Poor - exposed clay	Good (word of mouth)
(c) Obstructions	No	Yes (trees ~2 H)
(d) Repres. Topography	Yes	Yes
(e) Roads/Transp.	Poor (Gravel road 250 m, parking area, driveway	Yes (main road 40 m/parking lot for store)
(f) Agriculture	No	No
(g) Towns/Cities	Yes (1 km, 1500-4000 pop.)	No
(h) Pollution Sources	Yes, paper mill 20 km W Yes, suspected woodstove 40 m	Lumbermill/sawmill burning (20 km/4 km), vegetable garden, Ca on road
(i) Power Failures	Limited	4/yr. main line (short duration)
(j) Deviations	Poor windbreak, ground cover Road, paper mill	Road, mills, obstructions
(k) Advantages		Representative of area
(l) Rating	Poor	Marginal (clearing should be enlarged)
II OPERATIONS		
(a) Condition of Instr. - Present	Reasonable, (poor resist.)	Poor (sensors burning, resist. etc.)
- Past	Suspected bad sealing	Uncertain
(b) Understanding - Has manual	Yes	Yes
- Read manual	No (partial)	yes
- Understand protocol	No	yes
(c) Following Protocol - Instr. Checks	No	No (Did not detect burning sensors)
- Sample Handling	No (poor)	Reasonable (needs upgrading)
- Cleaning	No	Yes (knife edge & gasket)
- Storage (Sample)	N/A	Refrigerator
- Std. Gauge Protocol	No	Yes
(d) Attitude	Good	Good
(e) Reaction to Problems	Good	Good
(f) Submission Forms	Good	Good
(g) Retraining Needed	Yes	Yes (upgrading)
(h) Deviations	Major re protocols	Instr. checks
(i) Advantages	No	Interested, quick to learn
(j) Rating	Poor	Good (requires slight upgrading)

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	7. MELBOURNE	8. NITHGROVE
I SITING		
(a) Windbreak	~90° (mixed)	~270° (mixed)
(b) Ground Cover	Good cover but tree <5 m	Good
(c) Obstructions	Yes (trees)	Yes (trees)
(d) Repres. Topography	At top of hill	Yes
(e) Roads/Transp.	Yes (gravel road 300 m, parking lot 30 m)	No (driveway only)
(f) Agriculture	Yes (<1 km)	No
(g) Towns/Cities	No (Melbourne (~ 5 km)	No
(h) Pollution Sources	Cement plant 4 km W, wood burning chimney 13 m away	Plywood plant 35 km, few livestock grazing near sampler, wood heating of house 60 m
(i) Power Failures	No	3 max./yr.
(j) Deviations	Road, hill, wood burning, open, obstr., agric.	Obstructions, livestock, wood burning
(k) Advantages	Remote, good ground cover	Remote, representative, windbreak
(l) Rating	Marginal (obstructions should be cut)	Good (contingent upon removing obstructions)
II OPERATIONS		
(a) Condition of Instr. - Present	Good (but sensors dirty)	Good (but off-level)
- Past	Indications from operator that aerochem misses events	Indications from operator of missed events
(b) Understanding - Has manual	Yes	Yes
- Read manual	No	Yes
- Understand protocol	No	Yes
(c) Following Protocol - Instr. Checks	N/A	N/A
- Sample Handling	No (poured out of bag; turned bag edges in)	Yes
- Cleaning	No (1 pair of gloves)	Yes
- Storage (Sample)	Refrig.	Refrig.
- Std. Gauge Protocol	Proper protocol, wrong precip. gauge	Yes (but off-level)
(d) Attitude	Good	Excellent
(e) Reaction to Problems	Good	Good
(f) Submission Forms	Good	Good
(g) Retraining Needed	Yes	No
(h) Deviations	Not following new protocol	No
(i) Advantages	Interested	Interested, skillful
(j) Rating	Marginal (must be upgraded)	Excellent

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	9. LONGWOODS	10. GRAHAM LAKE
I. SITING		
(a) Windbreak	~180° (mixed)	~270° (deciduous)
(b) Ground Cover	Good cover but other instr. <5 m	Good
(c) Obstructions	Yes (trees, F/P gauge)	No
(d) Repres. Topography	Yes	Yes
(e) Roads/Transp.	Yes (gravel access road 70 m, gravel conc. road 120 m)	Yes (Conc. Road, gravel, 35 m, above sampler height)
(f) Agriculture	Yes (tobacco <1 km)	No
(g) Towns/Cities	Yes (3 km, 1500 pop.) London/Strathroy, ~20/30 km	No
(h) Pollution Sources	Wood burning at garage ~40 m, vehicle maintenance garage ~50 m,	No
(i) Power Failures	1/month (power changed recently)	3-4/yr. but short duration
(j) Deviations	Obstructions, wood burning, road, vehicles, agriculture	Road, poor windbreak to S, hill to SE
(k) Advantages	Ground cover, representative of area	Remote, representative, no obstructions
(l) Rating	Marginal (cut trees)	Reasonable (would be good if windbreak existed between sampler and hill/road)
II OPERATIONS		
(a) Condition of Instr. - Present	Reasonable, hood slow in returning	Poor (off-level, holes in gasket, slow to return hood)
- Past	Operator indicated events missed by Aerochem	Snow & ice in dry side suggest missed events
(b) Understanding - Has manual	Yes	Operator N/A
- Read manual	No	"
- Understand protocol	Yes	"
(c) Following Protocol - Instr. Checks	N/A	"
- Sample Handling	No (1 set of gloves, rusty scissors)	"
- Cleaning	Yes	"
- Storage (Sample)	Refrig.	"
- Std. Gauge Protocol	Yes (but does not use funnel)	"
(d) Attitude	Good	"
(e) Reaction to Problems	Good	"
(f) Submission Forms	Good	"
(g) Retraining Needed	Yes (limited)	"
(h) Deviations	Gloves, nipher, scissors	"
(i) Advantages	Experienced	"
(j) Rating	Marginal (would be good with upgrading)	"

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	11. SHALLOW LAKE	12. McKELLAR
I SITING		
(a) Windbreak	~270° (mixed)	~200° (mixed)
(b) Ground Cover	Good	N/A
(c) Obstructions	No	Yes (pole [~1 H])
(d) Repres. Topography	Yes	Yes
(e) Roads/Transp.	Yes (Gravel County Road 350 m S, separated by barn)	Yes (paved hwy. 100 m S)
(f) Agriculture	Yes (hay field adjacent to site)	N/A (doubtful)
(g) Towns/Cities	Yes (two very small towns 2 km & 4 km plus Owen Sound 7 km)	Yes (McKellar - few km)
(h) Pollution Sources	Owen Sound, livestock nearby, garden 30 m, wood burning stove ~ 40 m	N/A (some livestock)
(i) Power Failures	3/yr.	N/A
(j) Deviations	Roadway, hay field, wood burning	Obstruction, highway
(k) Advantages		Ground cover, remote
(l) Rating	Marginal (good if hay field not there)	Reasonable (good if road not there)
II OPERATIONS		
(a) Condition of Instr. - Present	Reasonable (low resist., dirty, sensors oxidized)	Poor (inst. A off-level, low resistance, jerky hood, poor seal, sensors burnt, instr. B sensor not working)
- Past	Good	Evidence of many fuses blowing
(b) Understanding - Has manual	Yes	Operator N/A
- Read manual	Yes	"
- Understand protocol	Yes	"
(c) Following Protocol - Instr. Checks	Yes	"
- Sample Handling	Yes	"
- Cleaning	Yes (not body)	"
- Storage (Sample)	Basement (could be cleaner)	"
- Std. Gauge Protocol	Yes	"
(d) Attitude	Good	"
(e) Reaction to Problems	Good	"
(f) Submission Forms	Good	"
(g) Retraining Needed	Yes (operator requests upgrading on Lovol)	"
(h) Deviations		"
(i) Advantages	Interested, understanding of concepts	"
(j) Rating	Excellent	"

TABLE 3.1.2

Summary Fall 1983 Site Audit Findings

	13. COLCHESTER	
I SITING		
(a) Windbreak	Little	
(b) Ground Cover	Good, grass but fence <5 m	
(c) Obstructions	Yes (fence, Hydro line)	
(d) Repres. Topography	Yes	
(e) Roads/Transp.	Yes (3 tarred roads, driveway, parking lot - 100-150 m, 50-70 m, 25 m)	
(f) Agriculture	Yes (100 m W crops; 100 m E, 1 km N crops)	
(g) Towns/Cities	Yes (located in Colchester, pop. 500; Harrow 5 km, 2200 pop.), Windsor	
(h) Pollution Sources	Cl tanks, diesel generator (low use), ventilation ducts, playground	
(i) Power Failures	No (not a problem because of alternate power source)	
(j) Deviations	No windbreak, obstructions, roads, town, ventilation ducts, Lake Erie	
(k) Advantages	Good ground cover	
(l) Rating	Poor	
II OPERATIONS		
(a) Condition of Instr. - Present	Problems (Lovol not working properly, sensor resist. low, cold sensor)	
- Past	No	
(b) Understanding - Has manual	Yes	
- Read manual	Yes	
- Understand protocol	Yes	
(c) Following Protocol - Instr. Checks	N/A	
- Sample Handling	Yes	
- Cleaning	yes	
- Storage (Sample)	Lab	
- Std. Gauge Protocol	No (1 meas. centre of gauge)	
(d) Attitude	Good	
(e) Reaction to Problems	No (had not followed up on Lovol problem)	
(f) Submission Forms	Good	
(g) Retraining Needed	No	
(h) Deviations	Not calling when problem detected	
(i) Advantages	Understands and follows protocol	
(j) Rating	Good	

TABLE 3.1.3

Summary of Site Audit Ratings

SITING / OPERATIONS	EXCELLENT	GOOD	REASONABLE	MARGINAL	POOR
EXCELLENT	Golden Lake[11]	Nithgrove[6]		Shallow Lake[2]	
GOOD			Azure Lake[9]	Campbellford [10,3] Mattawa[8]	Colchester
REASONABLE					
MARGINAL				Melbourne[7] Alvinston[12] Longwoods[4,5]	
POOR					Moonbeam
UNRATED			McKellar[1] Graham Lake[3,1]		

1 Only partial information available to rate site
2 Would be GOOD if hayfield not there
3 Siting Rating ould be GOOD if windbreak existed between sampler & hill/road
4 Trees < 2.5 M should be cut, F-P moved
5 Operator would be good with upgrading and new scissors
6 Good rating contingent on removing trees
7 Trees should be cut
8 Clearing should be enlarged
9 Tree must be cut down; operator needs upgrading
10 Operator nees upgrading to winter protocol
11 Rating contingent on trees being cut down immediately
12 Requires immediate cutting of trees; operator needs upgrading

Several general observations were made during the site audits.

1. Operator's attitude towards their duties and the programme in general is quite good. In order to maintain this attitude it is recommended that the operators receive more feedback from APIOS head office. This feedback could be in the form of an APIOS newsletter as is mentioned in the APIOS QA Plan and/or some quantitative indication of the data that is being produced at the operator's site (a summary of sample pHs occurring at the site would be ideal.) Several operators mentioned they would be interested in participating in a yearly operator workshop at the MOE regional office to review and discuss sample handling procedures and the APIOS programme.

2. Most operators audited have never been retrained or upgraded to the most recent sample handling procedures. At some sites this presents a potential for sample contamination. This training should be carried out by the regional technologists as soon as possible (see section 4.5).

3. While all but one operator had received the most recent operating procedures only a few have taken the time to review them. The regional technologist should make available time during site visits (this could be done in conjunction with #2 above) to go through the documented procedures with the operators.

4. Instrumentation was operating close to the specification range set by APIOS. For some instruments (ex. Aerochem and Metrex Sequential Sampler) detailed specifications are not yet documented so that the instrument checks are usually more of a qualitative nature. Departures from the performance specifications were seen for the Sangamo/MIC sample in that

   - the sensor sensitivity was generally set very high (0 - 100 Ω) instead of the specified 220 KΩ

   - the clutch was set much greater on all samplers than the specified 14 lbs.

   An observation by the auditor and operators during the audit was that the Aerochem did often not activate for collection during a snowfall event. Constant heating of the Aerochem sensor would aid in the sensor's ability to detect snow. (a new sensor is presently being developed and evaluated under contract for APIOS).

5. Snow and ice which accumulates on the gauges and instruments should be cleaned off during the winter months in order to prevent incorrect precipitation depth determination and sample contamination due to blow off into the sample container.

Freeze thaw conditions can also lead to instrument freeze up and failure. This procedure should be done regularily by the operator and verified by the technologist during site visits.

6. All sites visited had sufficient inventory to carry out their required sampling responsibilities.

7. Procedures for record keeping other than operator sheets are quite variable and should be standardized(follow procedures in Operations Manual). The additional records (log books) that the operators keep should be incorporated into the operating procedures and data validation procedure.

3.2 Technologist Performance

During the Phase I Audit two regional technologists were visited, the technologist in the Southwest Region and the technologist in the Southeast Region. Each technologist is responsible for cumulative and event (daily) wet and dry deposition sampling stations and the associated sampling protocol. The primary objective of the technologist audits was to assess how well the technologist is performing his duties as described in the APIOS Technical & Operating Manual. A secondary objective is to assess recommendations made by the technologists for improvements to the operating procedures.

During each of the two technologist audits the regional event dry deposition sampling site was visited where an event wet deposition collector is also located. Blank questionnaires completed during these visits are included in Appendix III. Also in Appendix III is a listing of other questions that were discussed with the regional technologists, concerning their APIOS duties.

The findings of the technologist audit indicate that for the most part the regional technologists were following the operating and technical procedures as described elsewhere (Bardswick 1983a). There are a number of general areas however which the technologist does not fully follow the procedures. These are:

1) handling of filters (use of tweezers, area of filter handling, washing of filter packs, disposable gloves not being worn)
2) instrument calibration (Sangamo/MIC, Sequential and Low-Vol samplers)
3) routine maintenance of instrumentation
4) sample storage (at field sites and in regional offices)
5) operator training and upgrading
6) notifying head office of site changes

The technologists need to review their operating procedures and a training/review session be conducted by head office to instruct the technologist in areas which he is deviating from the documented

operating procedure. It is the opinion of auditor however that only "operator training and upgrading" (item #5 on previous page) is having an immediate adverse effect on sample integrity. The other points should be addressed at a retraining and upgrading course that should could be held at head office semi-annually for all regional technologists. It should be noted that the finalized documented procedures that were used for the technologist audits have only become available to APIOS personnel within the last six months.

Specific findings from the two technologist audits that could affect data quality and the appropriate corrective action that should be taken are shown below:

London and Kingston Audit Findings

1) Calibration of the Longwoods Sequential indicated the instrument "volume counter" recorder was only registering 75 % to 85 % of actual volumetric flow. The Charleston Lake sequential sample "volume counter" was registering 88 % to 95 % of actual volumetric flow. Corrective Action Calibrate Instrument.

2) Sequential daily total flow volumes have been dropping steadily over the past year at the Longwoods site. Corrective Action Service sampler pump and check plumbing connections for leaks.

3) Sequential sampler rotameter calibrations at both Longwoods and Charleston Lake are non-linear and at the operational rotameter reading of 25 ℓ/min are reading 5 % to 10 % greater than the actual flow. Corrective Action Calibrate rotameter routinely (every six months).

4) Sequential samplers in both southeast and southwest region have never been serviced by regional technologist. Corrective Action Follow routine maintenance procedures for sequential sampler described in the Technical and Operating Manual.

5) Parked vehicles (and especially left running) can be a significant source of contamination to samples being collected nearby. Corrective Action Vehicles should not be parked and/or left running near samplers (especially if samplers are downwind).

6) Only teflon coated tweezers should be used for filter handling. Tweezers for handling of W40, Nylon and Teflon filters should be kept in a separate rinsing solution than the impregnated W41 tweezer rinsing solution. Correction Action Review operating procedures.

Finally the regional technicians in APIOS are required to work independently out of MOE regional offices with minimal direct supervi-

sion while in the office and in the field. The auditor found that while some procedures are not followed to the letter (retraining would correct most of these) both technologist's performance was within the requirement for the collection of good data. Their relationship with site operators, ability to think independently, and solve problems while in the field make them one of the real strengths of the APIOS programme.

3.3 Performance of Data Validation and Screening Procedures

In discussions with APIOS personnel it was decided that the data audit would cover cumulative wet deposition data for the period July to December of 1981 (known as the study period). The data management system including data handling merging and editing is described elsewhere (Bardswick 1983a) and the data validation procedures for cumulative precipitation data in another document (Kirk 1983). The performance audit checked whether the procedures described in these two documents mentioned above were correctly applied and with the use of non-routine manual screening techniques if the auditor could identify areas where data quality was being affected. As is discussed in Section 4.6 the overall data management and validation procedures have been well thought out and have led to the reporting of qualified data.

The audited data set was made up of approximately 180 samples collected at 36 cumulative monitoring sites. The data used in the audit were from the following sources.

Final Reported Data	- APIOS Monthly/28 Day Cumulative Precipitation Chemistry Listing
Field Sheets	- sheets that contain details (eg. site name, sample #, sample type, comments about the sample etc.) of individual sample submissions. Prepared by regional technologists and submitted along with the sample to the laboratory.
Operator Sheets	- sheets that contain details of the on-site sample collection (eg. site name , sample type, operator name etc.). Prepared by the site operator.
Comment Summary	- summaries of office and field comments applied to cumulative data for the period July 15, 1981 to January 15, 1982. Individual summaries were prepared for each site.
CLIMAT Precipitation	- from the "Monthly Record of Meteorological Observations in Eastern Canada" (July 1981 - January 1982). Available from the Atmospheric Envrionment Service. Daily record of

precipitation depths occurring at meteorological stations.

Monthly Summaries - from "APIOS Cumulative Network Monthly Summary of Factors Affecting Samples". Summaries prepared by technologists of cumulative samples collected.

The checks that were made on the data were meant to:

- ensure that documented screening and validation checks were being properly carried out.

- detect errors in the data handling system that would not normally be detected using only the documented procedures

- use ancillary information (eg. CLIMAT records to verify that data are as complete, accurate, precise and comparable as possible.

A description of the checks carried out along with the findings are described below.

1. Check Operator Sheet against Field Sheet. This involved manually comparing the data recorded on the operator sheet to those which are recorded on the field sheet. Field sheets were available for

all sites, while the operator sheets were available for all sites except those in the southeast region. A total of twenty four sites (approximately 140 samples) were examined.

Findings A summary of the discrepancies between the Field and Operator Sheets is shown in Table 3.3.1. In most cases the discrepancies appear to be due to an error in information transfer or missing information. It is recommended that the technologists be made aware of these types of discrepancies and a system introduced that would prevent them from occurring in the future. Such a system could involve the QA coordinator comparing the operator and field sheets every six months. When a discrepancy is found the technologist is made aware of it and a revised Field Sheet submitted.

2. Check Field Sheet against reported data (MOE, 1983). This involved manually comparing the data recorded on the field sheet with the APIOS cumulative precipitation reported data. Field Sheets and reported data were available for all sites for the period July 1981 to December 1981. A total of thirty six sites collected samples and there were data on approximately 180 samples. Approximately 50 % of the samples were spot checked.

TABLE 3.3.1

Discrepancies Between Field and Operator Sheets

		Number of Occurrences
1)	Sampling dates on operator sheet do not agree with dates on field sheet	8
2)	Sampling time on operator sheet does not agree with time on field sheet	13
3)	Operator recorded precipitation during sample change but Technologist did not	4
4)	Sampler malfunctioned during sampling period but Technologist did not provide a comment on the field sheet	7
5)	Operator sheet incomplete (e.g., no operator name or sampling date)	14
6)	No operator sheet	5
7)	Storage gauge reading on operator sheet does not agree with reading on field sheet	1
8)	Operator recorded comment about sample (insect, leaves, etc.) but Technologist did not record comment on field sheet	16
9)	Operator recording time as Eastern Standard Time during the summer and Technologist did not record times on field sheet as Daylight Saving Time	3 (only at Bear Island site)

Note: A total of 24 sites were checked (approx. 140 samples)

depths should be performed every six months by the QA Co-ordinator. If a discrepancy is found the regional technologist should be contacted to confirm the correct value and the data base changed accordingly.

4. Check Deviations from Specified Sampling Date and Time. This involved determining the specified APIOS sampling dates and times as is shown in Table 3.3.2 and then checking the reported date and time to see if a discrepancy occurs.

Findings After review of all samples in the study period it was determined that 29 % of all the samples had sampling dates that deviated from those shown in Table 3.3.2. The sampling time for 61 % of the samples were not within the specified 0700 to 0900 time period. The number of incorrect sampling dates and times should be determined semi-annually and the technologists informed of these deviations and the sites at which they are occurring. The QA Co-ordinator and regional technologist can then work towards having the regular operator change the sample at the specified date and time and if necessary the alternate operator can change the sample.

The APIOS sample collection protocol and subsequent integrity of samples relies in many cases on the goodwill of the site operators to carry out the required sample handling procedures. The QA Co-ordiantor will need to determine if the benefit from requiring

TABLE 3.3.2

APIOS Sampling Dates and Times For Audit Study Period for Cumulative Precipitation and Sample Collection

Sample Month	Sample Start Date	Sample End Date	Sample Time
July	June 30	July 31	0700 to 0900 local time
August	July 31	August 31	0700 to 0900 local time
September	August 31	September 30	0700 to 0900 local time
October	September 30	October 30	0700 to 0900 local time
November	October 30	November 30	0700 to 0900 local time
December	November 30	January 5	0700 to 0900 local time

the operators to adhere more closely to the sampling schedule will have a greater compensating negative effect on the operators good-will, which is very important to APIOS.

5. Check Data Validation Procedures. This involved determining if the procedures for validating cumulative data as described elsewhere (Kirk 1983) have been correctly executed. These procedures involve qualifying data through either an office comment applied to the entire sample (eg. calculated/observed pH discrepancy) or an unreliable comment (U) applied to an individual reported parameter. The type of procedures used to validate the data are:

   Sample Analysis Integrity Checks
   - Ionic Balance
   - Theoretical vs. Observed Conductance
   - Theoretical pH vs. Observed pH
   - Free Hydrogen vs. Total Hydrogen
   - Sample Representativeness - Collection Efficiency

   Gross Limit Checks

   Statistical Check for Outliers

   The execution of the data validation procedure (Kirk, 1983) were spot checked with the data supplied by APIOS for the audit.

Findings The procedures in all cases examined were correctly executed. The procedures themselves however might require modification. These proposed modifications will be discussed as part of the systems audit (Section 4.6).

6. Check Summary of Field and Office Comments. This involved tabulating site by site all the office and field comments for all the cumulative sites as well as the sampler collection efficiencies for the period July 10, 1981 to Jan. 15, 1982 (Table 3.3.3). This table provides a quick overview of the types of comments which are being appended to analyzed samples. The auditor then objectively and subjectively reviewed the table to identify potential site problems which could effect data quality. Certain field or office comments if occurring frequently can be good indicators of sampling contamination, poor instrument performance or non-representative siting as is described below.

Field Comment Code Index

A - Insects in sample

B - Leaves in sample

C - Particulates in sample

D - Fibres in sample

TABLE 3.3.3

Frequency of Field and Office Comments and Efficiencies

Station	Field Comments														Office Comments							# of Records	# of Records with office Comments	E%	E % Std. Dev.	Comments
	A	B	C	D	E	F	G	H	I	J	K	L	Q	?	C	H	J	M	N	T	X					
Colchester A	4		4	1			1	1											1			6	6	74	21	✓
Merlin	3		2				1	1				1							1			6	5	78	36	✓
Port Stanley	2		4	3			2								1	1			1			6	5	76	35	✓
Wilkesport	3		3	2															1			6	4	87	21	✓
Alvinston A	2	3	3	1												1		1	1			6	6	83	31	✓
Shallow Lake A		1	5	1			2	1	1										2			6	5	92	53	✓
Palmenston	1		2				2		1					M-1					2			6	3	60	22	?M?, Low E
Huron Park																					2	3	0	68	N/A	
Waterloo			3	3		1		1		1						1			2			6	6	64	42	? Low E, Nx2
																										Reg. Avg. E=76 %
Dorset	1		1					1		2		1	2						1			6	4	66	23	✓
Milton	3						1	1								1			3			6	4	57	33	? Low E Nx3
Uxbridge							1												2			6	1	61	36	? Low E, only 1 field comment
Wilberforce	1		4				2	2							1				2			6	4	57	38	? Low E Nx2
Campbellford	4			1			1	1											2			6	5	53	31	? Low E Nx2
Coldwater	2		1			1	1	1	1	1		1	1									4	3	70	12	✓
																										Reg. Avg. E=61 %
Kaladar			1			1	3	3	1	1					1				1			6	4	60	27	? Low E
Smith's Falls	5						2	2					1			2			2			6	5	65	28	✓
Dalhousie Mills	1	1	1	2			2	2					1		1	1		1				6	5	79	13	✓
Golden Lake A	1			1			1	1											2			6	3	106	86	✓
																										Reg. Avg. E=77 %
McKellar A	1		6	5	2		4	4											1			6	6	69	21	✓
Killarney	1		5	5			1	1										1	2			6	6	58	27	? Low E Nx2
Mattawa A	2		2	3	2		4	3					1						1			6	6	74	31	✓
Bear Island	1	3	5	5			2	2				1										6	6	75	29	✓
Ramsey A		1	5	6			2															6	6	79	9	✓
Gowganda	1		4	5		1	3	3				1							3			6	6	50	23	Low E Nx3
Moonbeam A	3		6	5		2	1	1	1						1	2			3			6	6	49	30	E, Nx3 Hx2
Whitney			1				3	1	2			1							1			6	6	60	10	? Low E
Attawapiskat	2		4	2			1	1							1	1		2	5			5	5	21	10	Bad E Nx5
																										Reg. Avg. E=51 %
Dorion	3		4	5		1				1												6	6	86	18	✓
Nakina	1		5	5		2		1		1		1	1		3	4		3	1			6	6	72	21	Mx3, Cx3, Hx4
Ear Falls	3		5	6		3	3	2	1	1									5			6	6	32	21	Poor E Nx5
Pickle Lake	2	1	5	4	1		2	2	1						3	2		2	3			6	6	51	24	Low E Nx3, Cx3
Quetico			1																			1	1			
Exp Lakes	1		1	2	1	1			1		1											3	3	92	15	✓
																										Reg. Avg. E=67 %

A - Site audited during Fall 1983 Audit ✓ - Number of field and/or office comments and E value acceptable ? - Check out reasons for multiple comments
* - Evaluate site characteristics

- can be an indicator of potential sample contamination. If occurring in conjuction with office comment C, H, J, M the potential for contamination is greater. If possible the source of the contamination should be identified and eliminated.

E - Sample not submitted

F - Sampler malfunctioned

G - Sample spilled or leaked

H - Volume incorrect

- comments E-H will lead to incomplete data being collected. The reason (eg. poor handling of sample, inferior sample bags, instrument performance) for frequent occurrence of these comments should be determined and corrective action taken if necessary.

I - Event(s) missed

J - Wet side open when not precipitating

K - No precipitation collected

L - Part of event missed

- comments I-L indicate that if any sample was collected it will not be completely representative of the deposition occurring over the entire sampling period. If occuring with field comment F and office comment N usually this indicates a problem with either the collector or the 115 VAC power line. Discussions with the field

technologist usually reveals the cause of the problem and appropriate corrective action can be taken.

Office Comment Code Index

C - calculated/observed conductance discrepancy

H - calculated/observed pH discrepancy

J - Δ pH large

M - poor ionic balance

T - free hydrogen exceeds total hydrogen

- comments C-M and T indicate poor sampler quality. This can be due to contamination, through improper operator handling of samples or due to wind blown contamination (usually occurs with Field Comments A-D). These comments may also be the result of lab analysis problems.

The source of the contamination should be identified and eliminated if possible.

N - abnormal sampler efficiency

Indicates an abnormal sampler collection efficiency (determined against Storage Gauge) less than 50 % or greater than 120 % which usually implies an instrument problem during the sampling period (during winter

months elevated windspeeds can also lead to low collection efficiencies). High collection efficiense (>150 %) can also be due to inaccurate storage gauge headings. The abnormal sampler efficiency should be discussed with the appropriate technologist and the cause of the problem corrected if possible.

Findings Table 3.3.3 shows the frequency of the field and office comments along with sampler efficiency collection for the period July 15, 1981 to January 15, 1982 for cumulative precipitation samples. At some sites there is a potential for data quality being affected (sites indicated by ?) These sites should have the cause for multiple comments or low efficiency determined. Corrective action should be taken if possible to correct the cause. For other sites (Gowganda, Moonbeam, Attawapiskat, Nakina, Ear Falls and Pickle Lake) immediate action should be taken to determine why so many comments are being generated and correct the cause of the problem.

7. Check Inter-site Comparison. This involved subjectively comparing nearby sites to see if any bias at a site could be detected. The four groupings of sites used were:

1 Dorion, Pickle Lake and Nakina
2 Waterloo, Milton and Palmerston
3 Ramsey, Gowganda, Bear Island and Moonbeam
4 Golden Lake, Whitney, Dorset and Mattawa

Note: Some of the above sites have been replaced.

The data from the sites were compared for frequency of office or field comments, comparison of monthly pH measurements, comparison of possible soil contamination parameters (Ca, Mg), and comparison of possible human or road salt contamination parameters (Na, Cl). The study period was from July 1981 to December 1981.

Findings Table 3.3.4 shows any suspected bias of data collected at a site determined by comparing the individual parameters (eg. Table 3.3.5 Inter Station Comparison. Dorion, Pickle Lake, Nakina) of the nearby sites. Causes for the biases should be determined and corrective action taken to eliminate the cause. For example it is suspected that at Dorset construction was occurring near the sampling site during the study period which possibly led to high soil contamination parameters. This possiblility should be checked by examining on site operator records to determine if and when the construction did occur. If a correlation between the construction period, and the period of high soil contamination is found this information should be reported in the forthcoming semi-annual data quality report. If no correlation is found other sources of soil contamination should be evaluated.

TABLE 3.3.4

Inter-site Comparison (July 1981 to December 1981)

Site Grouping	Suspected bias due to:
1) Dorion, Pickle Lake, Nakina (see Table 3.3.5)	Nakina and Pickle Lake - soil contamination due to elevated Ca and Mg and office comments C and/or M five out of the six months and high pH's - Nakina and Pickle Lake - human or road salt contamination due to elevated Na and Cl and office comment C and/or M five out of six months and high pH's
2) Waterloo, Milton, Palmerston	Milton - possible soil contamination due to elevated Mg No other detectable bias
3) Ramsey, Gowganda, Bear Island and Moonbeam	Moonbeam - soil contamination due to elevated Ca (2 months [Ca] > 0.6 mg/l) and Mg 4 months [Mg] > 0.05 mg/l) and high pH's (4 months pH > 5.0)
4) Golden Lake, Whitney, Dorset and Mattawa	Mattawa - sample handling problem due to 4 out of 6 months sample spilled or leaked (field comment G) Whitney - also appears to have sample handling problem. Same reason as above. Dorset - soil contamination and possible human or road salt contamination for highest [Ca] 5 out of 6 months, highest [Cl] 5 out of 6 months, highest [Mg] 2 out of 6 months and highest [K] 3 out of 6 months.

TABLE 3.3.5

Inter-Station Comparison
Dorion, Pickle Lake, Nakina

Station	Gauge Depth	E	Field Comment	Office Comment	Volume	pH Lab	$SO_4^=$	NO_3^-	Ca	Cl	Mg	K	Na
July													
Dorion	14.0	94	AD	/	430	5.57	1.85	0.28	0.21	0.07	0.045	0.020	0.050
Pickle Lake	47.0	/	ACG	NCM	460	6.57	2.35	0.11	0.49	0.27	0.135	0.570	3.500
Nakina	20.0	90	AD	/	585	6.32	0.50	0.12	0.34	0.09	0.075	0.020	0.010
August													
Dorion	41.0	84	ACD	/	1125	4.89	0.80	0.11	0.06	0.08	0.020	0.050	0.020
Pickle Lake	20.7	/	HICE	/	/	/	/	/	/	/	/	/	/
Nakina	32.5	86	DC	HCM	915	5.68	0.30	0.07	0.23	0.10	0.045	0.020	0.010
September													
Dorion	102.0	88	AD	/	2945	4.59	1.50	0.20	0.06	0.02	0.010	0.010	0.020
Pickle Lake	70.0	/	BDGH	NH	650	5.89	1.05	0.14	0.40	0.06	0.075	0.070	0.182
Nakina	37.5	81	CD	M	990	6.88	1.30	0.18	1.63	0.22	0.295	0.030	0.030
October													
Dorion	57.5	75	CD	/	1416	4.44	1.60	0.30	0.12	0.06	0.010	0.030	0.050
Pickle Lake	39.2	71	ACD	C	914	4.95	1.25	0.20	0.36	0.06	0.060	0.050	0.156
Nakina	33.6	72	CFH	HCM	794	5.82	1.75	0.28	0.80	0.09	0.170	0.020	0.020
November													
Dorion	27.0	112	CD	/	990	4.30	1.95	0.57	0.17	<.01	0.025	0.020	0.050
Pickle Lake	40.0	80	CD	HCM	1039	6.88	1.15	0.26	1.63	<.01	0.310	0.020	0.182
Nakina	44.9	33	CDQL	NHC	488	6.87	2.15	0.45	1.97	0.09	0.420	0.020	0.040
December													
Dorion	40.0	59	CFJ	/	772	4.36	1.30	0.42	0.07	0.10	0.005	0.010	0.030
Pickle Lake	67.8	43	CD	N	957	4.73	0.55	0.17	0.10	0.09	0.010	0.020	0.050
Nakina	22.5	66	CDJF	NHC	489	4.37	0.80	0.48	0.10	0.10	0.010	0.020	0.030

The existing computerized data validation system is quite good in determining if the individual parameters are within certain limits (determined from historical data), or if the chemistry of the sample satisfies what can theoretically occur in rainwater samples (eg. integrity checks) or if a value is a statistical outlier. This information is valuable in assessing the quality of data being collected. The system however does not provide the necessary checks to detect and help prevent factors which can affect the quality of data being collected (eg. soil contamination, instrument performance). It is recommended that additional manual screening be employed in order to allow problem areas to be detected quickly and corrective action taken. As described in this section areas where manual screening could be effectively implemented into APIOS include (some manual screening is presently being done in some of the areas listed below).

1 Checking operator sheet against field sheet
2 Checking Field sheets against reported data
3 Storage gauge depth check
4 Deviations from scheduled sampling date and time
5 Field and Office Comment Summary
6 Intersite Comparisons

4. SYSTEM RELATED AUDIT FINDINGS

The primary objective of the APIOS networks is the quanification of both wet and dry depositon patterns across the province of Ontario (Chan et al., 1982). The system related audit procedures involved reviewing network operations and systems to determine how well they satisfy the objectives of the APIOS monitoring network.

The quality of the data collected from the monitoring networks is quality assured by a number of quality control procedures. Through these quality control procedures quantification of data accuracy, precision and completeness is possible. These procedures also act as a means of detecting and preventing problems that can occur in the APIOS.

The findings of the systems audit after reviewing the overall operating system and the QA system generally assures that good quality data is being reported. Marked improvements since the 1982 audit were noticed in the areas of network documentation, data validation and the implementation of additional quality control routine procedures (eg. QC samples, co-located samplers) that will allow quantification of data quality. Since data from the recently implemented routine QA procedures is not yet available, it was not possible in the Phase I audit to quantify data quality. It is expected that this qualification will be possible during the Phase II audit.

The forthcoming QA Manual will bring together all the necessary QA procedures into a system that will enable data quality to be quantified, and to ensure the operating procedures are being carried out correctly. The QA manual preparation should be carried out as soon as possible.

This section discusses areas where changes could be made to the existing operating procedures and also additional procedures that should be developed and incorporated into the QA Manual. Recommendations from this section are summarized in Chapter 5.

4.1 Network Documentation

Documentation as described elsewhere (Vet, 1983) can fall into a number of different areas:

Reports	- data*, network quality assurance, audit, laboratory quality assurance
Log books	- site*, regional, head office (Qa co-ordinator) special studies
Forms	- operator*, field submission*, lab submission*, site change*, corrective action, site description*

Job Description	- APIOS project manager*, technical co-ordinator*, QA coordinator*, technologist*, operator*
Manuals	- operator*, field operations*, instrumentation*, laboratory operations* QA
Background Documents	- APIOS overview*, site description*, QA Plan*

* already exist as part of a separate document

A description of the contents of each of the documents above should be included in the QA Manual (forthcoming from APIOS) along with the appropriate documentation control system that assures the document will be periodically reviewed, updated if necessary and any updated documents distributed to the appropriate personnel. Within APIOS the operational manuals, copies of forms and an APIOS overview are contained in one main document (Technical and Operating Manual, Bardswick 1983a). This manual contains almost all of the information required to operate the network from a technical standpoint. It makes use of a well thought out documentation control and distribution system and is a major improvement since the 1982 audit was carried out. The one criticism is that it is not geared specifically to its intended user. It is a good manual for a technical or network co-ordinator but its usefulness decreases as an operational manual. Evidence of this was noted during the site audits where most operators were unsure about the use of the

manual. It is recommended that the existing manual be used for personnel responsible for management of field operations (technical co-ordinator) and that parts of the manual be used to prepare a separate Operator's manual, Field Operation's Manual (for technologists) and Instrument Manual.

The most important recommendation from this audit concerning network documentation is that the forthcoming QA Manual be prepared as soon as possible for it will insure that the many QA procedures described in the APIOS QA Plan (Bardswick 1983b) are developed (if they aren't already) and implemented. This will assure that the quality of data (accuracy, precision, completeness) produced by APIOS may be quantified. Also procedures from the QA manual should be put in place to detect problems and correct them, and preventive type procedures instituted to prevent problems from occurring in the future. It should also contain details of the contents of the periodic QA reports to be produced by APIOS, job descriptions of personnel within APIOS and sources of the background documents (eg. overview of the network, QA Plan).

In reviewing the network documentation other procedures that should be developed and or documented are:

- calibration procedures for the most part for APIOS instruments and gauges have been developed and are described elsewhere

(Bardswick, 1983a). In order to be better able to quantify instrument performance, procedures should be further developed for the Sangamo/M.I.C. and the Aerochem Metrics samplers. All calibration procedures should include a schedule for the frequency and time of year when the calibrations should be carried out. Included in the forthcoming QA manual should be a description of procedures for how the calibration results will be used to validate data.

- servicing procedures for APIOS instrumentation for both operators and technologists, including a trouble shooting guide should be included in a proposed instrument manual.

- a description of the initial training programme for new operators and new technologists along with an upgrade training programme to be carried out on a routine basis or when new procedures are introduced or should be included in the QA Manual.

- detailed Corrective Action Procedures to be carried out when a problem is detected. Some of these procedures (eg. Site Change Form) have been partially developed. The completed documentation should be described in the QA Manual and then incorporated where necessary into the routine operating procedures.

- the routine and non-routine QA procedures that will be used to assess data accuracy, precision, completeness, comparability representativeness should be included in the QA Manual (section 4.8). The development of these procedures will not be straight forward especially for such things as accuracy with regards to wet deposition data, but is very necessary in providing data users with an estimate of how "good" the data is. Work being done by other groups (NADP) should prove helpful in this development.

Much of the basic document framework for APIOS has been prepared with the completion of the "Technical and Operating Manual" and the "APIOS QA Plan". In order to tie all the documents and missing information together and to assure the production of quality data, the preparation of the QA Manual is required. With this document many of the recommendations included in this report would be satisfied. Using the QA Plan as a guideline and input from the Phase I Audit the QA Manual preparation should begin as soon as possible.

4.2 Sampling Protocol

The sampling protocol for the sake of this audit includes the tasks carried out by the operators and technologists for the preparation, handling, storage and shipment of wet and dry deposition samples.

It will also include other ancillary tasks, such as the storage gauge procedures, which do not directly affect deposition samples, but do lead to the collection of deposition related data.

In general the sampling protocol developed and used by APIOS is quite rigorous in collecting representative and comparable samples with a minimal potential for sample contamination. During the site and technologist audit and in reviewing the documented procedures however modifications to the sampling protocol should be considered. These include:

1. In the cumulative wet and the event wet sampling protocol the operator puts a gloved hand inside the sample bucket to smooth the bag and improve its fit in the bucket. The procedure specifically states this "only be done using a new clean disposable plastic glove". It was noted during the site audits that often the operator does not put on a new glove and so carrying over contamination from other previous procedures is a definite possibility. Even when operators did put on a new glove they often contacted surfaces with the gloved hand prior to touching the sample bag. In one case when the operator placed his hand in the bucket part of his clothing touched the sample bag surface. Unless the operator thoroughly understands how easy it is to contaminate precipitation samples the potential for sample contamination is great.

It is recommended that another method be adapted to have the sample bag fit the bucket properly. Two possible methods to be considered are discussed in Section 4.3.

2. In the Operating Manual as part of the Cumulative Wet Operator Procedures there are no instructions as to where the collected samples should be stored. In order to minimize any post sampling contamination effects (eg. biological activity) it is recommended that where possible the samples be stored in a refrigerator and that technologists not expose the samples to temperature above 4° C for any extended period of time i.e. don't leave samples sitting in uncooled container in the back of a van for 2 or 3 days as was noted during this audit.

3. The washing of filter packs along with filter handling procedures for use in the cumulative and event dry deposition sampling programmes can, if not carried out properly, be a significant source of contamination . The regional laboratory set-up will usually dictate what facilities are available for washing the filter packs. (eg. Southwest Region). In order that the effect of filter pack washing can be quantitatively determined, it is recommended an extra pack (Handling Blank) be loaded monthly, taken out to the event dry deposition site, left in its bag in the sampling building, returned along with the corresponding week of filter samples, and

submitted to the lab for analysis. This Handling Blank would also yield information on other sources of contamination due to handling. A handling blank procedure is described in the Operating and Procedures Manual, but does not cover the full range of potential contamination sources mentioned above.

4. It is recommended that the operator and technologist be instructed to clear any snow accumulation off of the Sangamo/MIC and Aerochem Metrics during winter months. The accumulated snow can be wind blown and collected in the sample bucket and during freeze thaw conditions can lead to instrument freeze-up and failure.

5. At one event site the operator was still using a standard rain gauge during the winter sampling period when the Nipher should be used. A schedule included in the operating procedures of when instruments and gauges are to be used during different times of the year would prevent this problem occuring in the future.

4.3 Instrumentation

Sampling instrumentation for collection of wet and dry deposition has been evolving as the knowledge of the "acid rain" phenomenon has grown. Most of the sampling instrumentation used in APIOS has been

either modified, completely designed or developed and manufactured to satisfy the evolving needs of APIOS. While the present equipment has undergone a comprehensive development and approval programme, there are still some changes that could be incorporated to improve sample collection efficiency, instrument performance, and operator safety. One general consideration that was not taken into account in the past and might have significant impact on data collected, is in determining the sampling orifice area which is used along with the volume to calculate precipitation depths. In determining the orifice area the inside diameter of the sampling bucket or gauge is used by APIOS. NADP instead uses the diameter of the midpoint between the outside surface and the inside surface of the bucket to determine orifice diameter. The argument for this being that of the precipitation droplets that hit the bucket rim, half will fall into the bucket and half will fall to the outside of the bucket. This change in orifice area should be considered for the Aerochem Metric bucket. Suggested changes to sampling equipment are discussed below as part of the respective instrument.

Sangamo/MIC Cummulative Wet Deposition Sampler

- to prevent shorting between the sensing, heating and temperature-thermistor control circuits and eventual component failure, seal the exposed pin tops on the sensor card face with a weatherproof, non UV degradable material such as epoxy or polyester. Similar protection should be given to where the

card pins make contact with pin sockets. This could be done by providing a gasket that would fit between the sensor card back and the pin sockets.

- many of the components that are used on the Printed Circuit Board (PCB) are not rated to be used in a cold environment or under conditions of condensing relative humidity (CRH). The performance of the PCB components under these extreme conditions cannot be predicted and so instrument performance cannot be predicted. This problem could be solved by using components that are rated for the extremes that APIOS instrumentation are exposed to. Another possibility is the addition of a thermostatically controlled heater in the instrument housing to prevent the components being exposed to colder temperatures and prevent the quick drops in temperature which often lead to CRH.

- the use of protective screw on caps that fit over the limit switch plungers would prevent damage to the switches and subsequent instrument failure caused by overtravel of the instrument cover arms.

- substituting the existing stainless steel splash screen on the hood with a peaked teflon coated roof (similar design to Aerochem Metrics) would prevent snow and ice accumulation and

subsequent blow off into the sampler bucket. The decreased weight of the cover by removing the ice and snow would also decrease the strain on sampler components (motor, sprocket, chain)

- the use of a weatherproof military type connector on the sampler arm connection wire would allow for ease of installation and servicing of the instrument.

- in order to quantify and better predict sampler performance (eg. sensitivity to rain drop size and intensity) it is recommended that work be carried out to develop a new type of precipitation sensor that would be able to maintain consistent sensor temperature over a wide temperature range and wind speed, and when detecting precipitation the sensor be set to detect a certain minimal rainfall rate (this takes into account both drop size and intensity) not be simply an on-off type sensor which has variable performance depending on climatic conditions as is presently being used. This recommendation could be acted on as a special study.

- as was mentioned in the section on sampling protocol (Section 4.2) a new method for improving the bag fit is needed to avoid possible contamination by the operator. One reason for the

problem is that trapped air in between the bucket wall and the bag is not able to escape (only true for short buckets, problem is decreased with long sampling tubes) preventing the sample bag from laying flat against the bucket wall. Also, it is necessary that the diameter of the bag is larger than the inside diameter of the bucket in order to fit over the outside of the bucket. This leads to oversized sample bag and an imperfect bag fit inside the bucket.

An improved bag fit could be accomplished through evacuating the air in between the sample bag and bucket walls (using a pump and tubing connection or by applying a small vacuum unit, to an outlet on the bucket wall). Another method would be to hold the bottom of the bag in the bucket (through a clip or rod) and pull the portion of the bag that is folded over onto the outside of the bucket down until a good bag fit is achieved.

Aerochem Metric Event Wet Deposition Sampler

- to improve the sample bag fit see the discussion above

- the sensor of the sampler especially during winter months at times is quite insensitive to the detection of precipitation. This is due to both the spacing of the pair of sensor grids

and the lack of sufficient sensor heating. The present work being done by APIOS in replacing the existing sensor with a Sangamo/MIC type sensor should improve sensor response and will also improve comparability with the cumulative wet deposition sampler.

- the use of a flexible "boot" over the cover arms where they meet the sampler body would help prevent the freeze up problem that can occur during winter months.

Metrex Sequential Event Dry Deposition Sampler

- replacement of the rotameter with a mass flowmeter and recorder system would give a good check on the measured gas meter volumes and a more accurate determination of the flow rate.

- adding accumulated time counters on each channel of the instrument would give a check on the clock accuracy and an indication of any flow stoppages (eg. hydro failure) during the sampling interval

Metrex Low - Vol Cumulative Dry Deposition Samplers

- frequent failure of the sampling pumps requires that a more reliable pump be found and as the old pumps fail they should be replaced with the new more reliable model.

Cumulative Storage Gauge

- the orifice height above ground level should be standardized for summer and winter sampling. Presently this height may vary from 1 - 2.5 metres.

- the large volume of ethylene glycol and methanol that is required for wintertime sampling presents a handling problem both in getting the chemicals to the sites and in disposing of them during the spring changeover. The use of a simple immersion type water heater and thermostat in the wall of the storage gauge (temperature set to 5° C minimum) should prevent this problem, because the summer gauge solution of water, with a capping layer of oil could be used all year round.

Nipher Shielded Wintertime Event Precipitation Gauge

- the support stand for removing the collection vessel from inside the nipher shield is unsafe and should be replaced with a more steady type of stand (preferably with stairs and handrails).

- caps for the collection vessel should be provided so as to minimize spillage and evaporation while the collected sample in melted.

On Site Electrical

- all the site electrical supply lines for the 115 VAC samplers should be protected by a Ground Fault Interrupt Circuit (GFIC) either in the fuse panel or preferably at the receptacle.

- the receptacle should have a cover (preferable aluminum or stainless steel) to prevent precipitation from contacting the receptacle with a hinged front door for access to the receptacle

4.4 Site Representativeness

Site representativeness in APIOS is guided by the "Site Selection Criteria" (Bardswick 1983a) that are used for the finding, evaluating and approving of sites along with the internal and external auditing of these sites. Someone evaluating a site has to also be aware of network objectives and then uses the criteria as a guideline making "tradeoffs" of good and bad points about the site in determining how "good" a site it is. This makes it hard then to rate a site relative to the other sites in the network, for often the "tradeoffs" necessary in one area are not necessary in another (eg. agriculture in Southwest Region). In determining then how good the APIOS "Site Selection Criteria" are, this fact must be kept in mind. The criteria must provide a good guideline but still allow the evaluator to make an objective and subjective decision of "how good" the site is.

In APIOS the same criteria are used for both cumulative and event monitoring sites. This is fine except that the auditor generally should come closer to satisfying all criteria for cumulative sites then he does for event. This is due to any degradading sample effects (dust, wind shadowing, power supply problems) on site would be easier to spot, and corrective action taken in the event network than they would in cumulative due to the difference in sampling period and on site record keeping. This fact should be kept in mind when APIOS personnel are carrying out siting, internal auditing and rating of sites.

The siting criteria are generally quite good, however there are several points that are not covered sufficiently. These are:

- criterion #3 (Bardswick 1983a) states "no object should be located within 5 meters of the sampler which extends above the height of the sampler." With the addition of colocated instruments and other equipment in instrument compounds, often instruments are located within 1 or 2 metres of each other. There is a large potential then for windshadowing effects or blowoff of snow or dust into a nearby sampler bucket. It is suggested that this criterion be changed to have nothing above ground level within 5 metres of the samplers.

- it is always difficult to site an instrument in a predominantly agricultural area due to the potential of contamination from windblown soil, pesticides and herbicides. It is suggested that the criteria include, that for sites in an agricultural area that the site have a windbreak around 360°, and that there be no spraying of herbicides insecticides or pesticides within 1 km. This way the short range effect of the agricultural area would not be detected at the site, but the site would be regionally representative.

- the windbreaks on site especially in the prevailing wind direction (preferably coniferous type trees) are very impor-

tant in improving collection efficiency while decreasing potential contamination. While many of the APIOS sites do not have a sufficient windbreak, the need for a good windbreak should be included in the criteria.

- the direct and indirect effect of buildings nearby to the sampling can be quite substantial. Ideally any building should be located 4 to 5 time the heights of the building away from the sampler and should not be considered as windbreaks (this is due to the building wake effects on wind velocity and turbulence). An indirect effect is the potential for sample contamination due to woodburning heating units. This effect was noted by the auditor during site visits to Longwoods and Charleston Lakes. The criteria should reflect the need to avoid these factors.

- at most sites it is usually impossible to locate the site not within 1 km of roads. While it is preferable not to have roads nearby (especially heavily travelled routes), if a road is near to the sites it should be separated from the site by a row of coniferous trees.

4.5 Corrective Action

It is necessary that APIOS have a formalized corrective action system in order to maintain a high degree of data quality. There are a number of elements of a correction action system (eg. site change forms), already existing throughout APIOS procedures but an overall system (including reporting and follow up) has not yet been devised to deal with both immediate problems (eg. instrument not functioning) and long term problems of deviations from APIOS procedures (eg. site ranking is poor). The corrective action system should be fully described in the upcoming APIOS QA Manual.

Corrective action systems needs to be "closed loop" i.e. after a problem has been detected a number of steps should be followed until it can be verified that the corrective action taken has eliminated the problem. The typical steps that should be part of the system are: (from USEPA 1976).

a) define the problem;
b) assign responsibility for investigating the problem;
c) investigate and determine the cause of the problem;
d) determine corrective action to eliminate the problem;
e) assign and accept responsibility for implementing corrective action;

f) establish effectiveness of the corrective action and implement the correction;

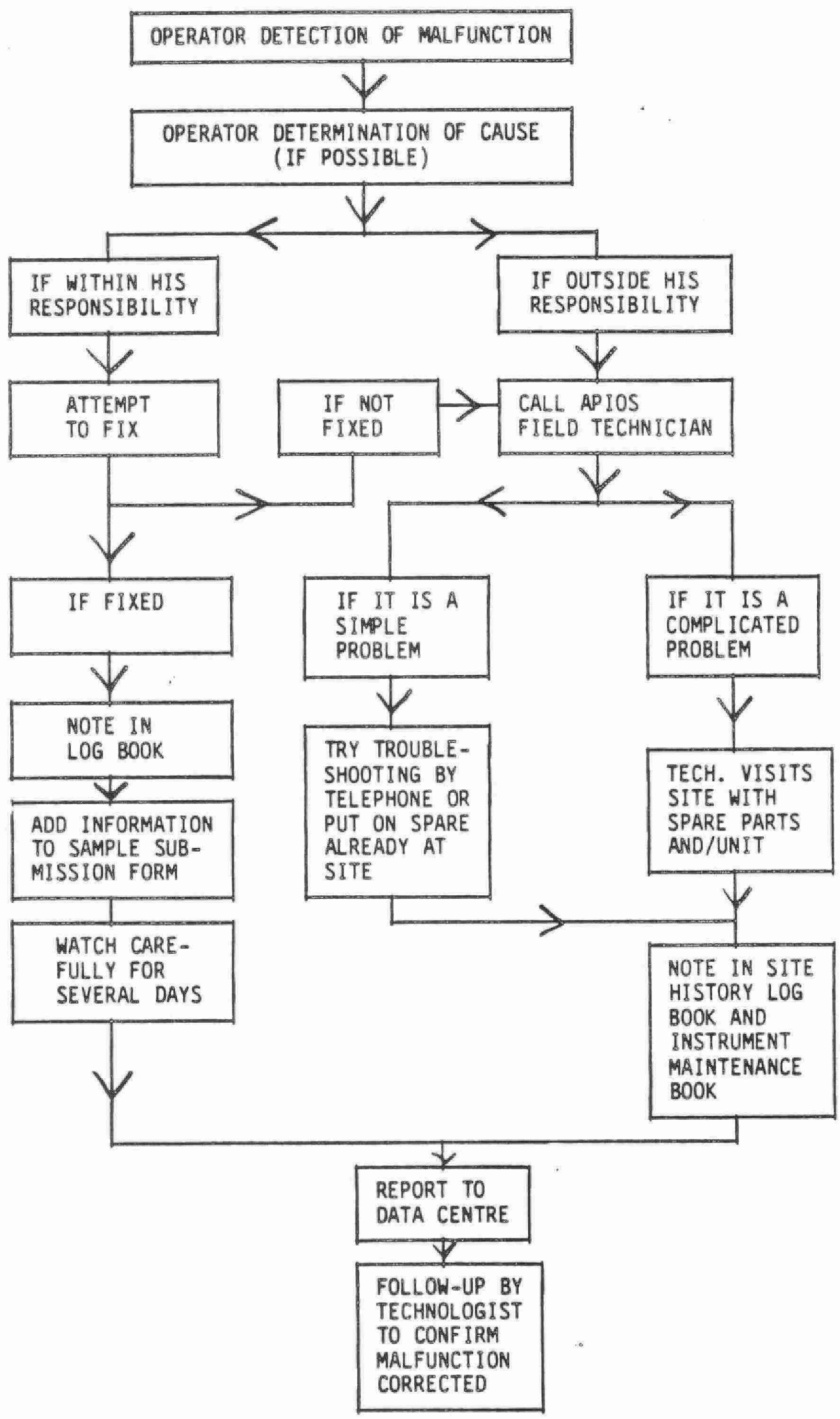
g) verify that corrective action has eliminated the problem

The USEPA document also suggests that a corrective action form be used when a problem is identified that includes the steps mentioned above and that a Master Log be kept of all the corrective action forms. Each of the various elements within APIOS should have its own system for corrective action (site operations, regional office-technologist operations, data validation operations etc.) An example of how this system might be set up for the operator operations/specifically an instrument malfunction in shown in Figure 4.5.1. It is important to keep good records as part of the corrective action system to assure action is taken to correct problems (especially important in APIOS because of the large extent of different sampling operations) and to note if the problem recurs (may indicate an operational problem).

In preparing the overall corrective action system two tasks will be necessary. The first, already discussed, is to develop and document the corrective action system in the QA Manual. The second step is to incorporate the corrective action system procedure into the various operations manuals of APIOS. These two tasks should be carried out as soon as possible.

FIGURE 4.5.1

Example of A Corrective Action Scheme For Field Operators



4.6 Training

As with all other procedures in APIOS there should be some documentation describing the objectives, responsibilities frequencies and tasks of the training programme. Presently it is up to the discretion of the technologist or the network co-ordinator to design and institute the training required at any specific time.

The need for developing a training system appeared during the site and technologist audits. The new Technical and Operating Manual (Bardswick 1983a) was distributed to network personnel (including operators), but field personnel were not clear on how the new procedures should be incorporated into an operator training programme. Some technologists just distributed the manual to their operators without any follow up, some showed the operator what changes to the procedures had occurred, while others requested that the operator telephone the technologist with any questions on the documented procedures. While this example reflects the need for documented training procedures it does not reflect the quality of the training the operators or technologists have received, for in general the competence in executing the procedures and comparability between the various operators and technologists is very good.

The training system should contain two types of procedures.

1) A programme to educate all network personnel of their responsibilities and tasks at the beginning of their participation in APIOS.

2) A programme to update and upgrade all network personnel to account for changes and/or additions to their duties and to minimize the adverse effects due to lapsed time.

Number 1 above is done quite effectively when a new technologist or operator joins the network. This initial training may be through an intensive training course at head-office or by on site training. Number 2 above however is not carried out so effectively as the Phase I Audit showed. There are some effective procedures that are currently carried out for upgrading technologists such as the quarterly technical meetings at head office but these procedures should be incorporated into an overall system so that all personnel (including operators) receive the updating or upgrading with the least possible delay.

Several examples of initial and upgrade or update type training that might prove effective for APIOS are:

- semi-annual (coinciding with changeover) operator update training sessions to be held at the regional offices.

- during the procedures audit technologists would demonstrate revised sample handling procedures to the operator.

- follow-up visits to new and updated operations to assure procedures are correctly implemented.

- have instrument manufacturer come to quarterly technical meeting to answer technical questions and demonstrate maintenance and servicing techniques of instrumentation.

- operational personnel from monitoring networks comparable with APIOS should be invited to demonstrate modified sample handling techniques, instrument maintenance, and servicing.

- to insure comparability between all personnel have one person carry out and update and upgrade training of operators and technologists.

The training system should describe both preventive and detection type quality assurance training procedures. The preventive procedures help to assure that all personnel in the network are trained in the most current operating procedures. These procedures work towards preventing inadequacies in training through procedures which are carried out on a routine basis (eg. quarterly technologist upgrading). The detection type training procedures allow personnel to detect when

problems occur so that corrective action may be instituted (e.g., internal audits, external audits, periodic reviewing of field sheets and sample summaries).

It is recommended that technologists immediately review current operating procedures with their operators and that the training system be fully developed and incorporated into the upcoming QA Manual.

4.7 Data Management and Validation Procedures

As part of the terms of reference for the audit programme APIOS requested that the Phase I data audit only deal with cumulative wet deposition data. This section will only discuss the procedures which apply directly to the quality assurance of these data.

Since the 1982 audit was carried out the APIOS Data Screening and Validation System has been documented (Kirk 1983) and included as part of APIOS Data Management (Bardswick 1983a). Computerized screening techniques have been developed (integrity checks, gross limit checks, and outlier checks) that allow the data to be qualified for users. Some basic manual screening procedures have also been developed. This section will discuss additional manual screening and validation procedures that should be considered and comments on the existing computerized techniques.

The APIOS documentation mentions that field sheets are visually screened for missing information, incorrect dates and times and illogical coding. A description of how and by whom these checks are carried out should be included in the forthcoming QA Manual. The need for manual checking is great for it gives an early indication of problems which might affect data quality, so that corrective action can be initiated. Other additional Manual checks that would help assure APIOS data quality are:

- comparison of the operator and field sheets for correct data transfer

- manual spot checking of the calculated storage gauge depth (possibly could be a computerized check).

- the QA co-ordinator should keep a running record of field comments and instrument malfunctions at each site to spot adverse trends that would affect data quality.

- the field technologist should be given copies of the qualifying remarks appended to samples so that site records and technologist records may be checked and the potential effects leading to the qualifying comments may be documented as part of the sample history. This type of information can be of great value to data users who are trying to determine what

effect activities such as woodburning stoves, road dust and biological material have on sample integrity.

It is important that most levels of personnel (regional technologists, head office technologists, technical co-ordinator and the database scientist) all be involved in some manual screening of data. When each person becomes familiar with applying various quality control data screening procedures their ability to spot errors and potential problems in network operations and also prevent them increases. This is especially important at the field-technologist level for this person best understands the requirements, limitations and potential sources of problems in the sampling system that can affect data quality.

The computerized screening and validation of APIOS data is primarily carried out by the database scientist who needs to understand the basic principles of the APIOS programme but does not need to have an indepth knowledge of the many factors that affect data quality in a large scale field programme. While he/she can carry out the various checks, subjective input from someone who is familiar with day to day operations of the network is required to properly qualify individual samples. For this reason it is recommended that the technical co-ordinator also become involved in the computerized screening, validation and qualifying of data.

The computerized procedures that have been developed are quite well conceived and allow the sample data to be evaluated in a number of different areas as mentioned earlier. While these procedures are quite good in picking out questionable data there are some modifications and development which might improve their effectiveness. These items will be described under the appropriate heading below.

Integrity Checks

The various Integrity Checks carried out on cumulative data limits for screening have been determined from cumulative frequency distributions compiled from historical daily precipitation data (Kirk 1983). If a parameter exceeded these limits the sample was flagged.

Event (daily) precipitation sampling; protocol, instrumentation and siting are different then those for cumulative precipitation sampling. It is expected then that the cumulative frequency distributions for the two types of data will be different and subsequently the upper and lower limits used for screening will be different. It is recommended that cumulative frequency distributions of historical event and cumulative precipitation data be compared and if they are significantly different then the upper and lower limits used for screening cumulative data should be adjusted accordingly.

Gross Limit Checks

In determining the gross limit of a parameter that is used, sites nearby to each other are grouped together on a seasonal basis and upper and lower limits for each parameter are determined from historical data cumulative frequency distributions. The assumption must be made that all samples for each month from the six or so grouped sites are from the same population. If one of the sites has a real factor associated with it (higher deposition) which causes a parameter to be constantly higher then the others in the grouping then there will be a bias towards higher gross limits being set. This will decrease the sensitivity of the test and hence its ability to detect high values. It is recommended that different groupings of sites be tried to see how the upper gross limits vary.

The 50 % and 120 % lower and upper limits that have been set for evaluation of sampler collection efficiency were subjectively chosen values after review of a group of typical precipitation sampling data. It is recommended that these two values be statistically redetermined from a cumulative frequency distribution of historical cumulative precipitation data and the 97.5 and 2.5 percentiles compared to the present values.

In order to remove the bias introduced by invalid data being part of the historical data set used for determining gross limits it is

recommeded that the historical data set be screened for outliers prior to the determination of the gross limit values.

Statistical Check For Outliers

Two factors that could be modified for the outlier test are the grouping of sites for the test and the use of the log of the parameter vs the parameter itself in the test.

The grouping of the sites should be evaluated to ensure all data are from the same population. If any one site's parameter is consistently flagged as an outlier than that grouping of sites should be reconsidered. If there was a non-representative factor present at one site it may be due to the wrong geographical grouping of sites or a "real" outlier situation.

It is assumed that deposition parameters, like most air quality data, are log normally distributed (USEPA 1976). Therefore the log of the parameter instead of the parameter should be considered when applying the Dixon Ratio Test for outliers.

The only other general comment is that in the Technical and Operating Manual it states that the screening and validation procedure are carried out and "suspect data are the thoroughly scrutinized so that a decision can be made whether to include these data into the database."

It is the auditors understanding that the philosophy of APIOS is to include all data in the data base with any appropriate qualifying flags appended to suspect data.

4.8 Routine and Non-Routine Procedures for the Assessment of Network Accuracy, Precision, Completeness, Comparability and Representativeness

One of the major objectives of APIOS quality assurance is to determine "how good" the data are that are being reported. In quality assurance terms this means how accurate, precise, complete, comparable and representative the data are. In the present auditing of APIOS most estimates of "how good" the data are, are based on qualitative evaluations of how well procedures are followed, whether the procedures are adequate to satisfy the APIOS objectives. A far more difficult task is to quantitatively describe "how good" the data are. In order to do this APIOS routine and non-routine QA procedures must be fully developed and the resulting data reported in order to allow values to be established for accuracy, precision, and completeness of the data set.

While some routine and non-routine procedures that could be used to assess accuracy, precision completeness, comparability and representativeness are described in the Technical and Operating Manual these procedures should be fully developed and described in detail in the forthcoming QA Manual. This manual should describe, who will carry

out the procedure, give a detailed step by step description of the procedure, what data will be reported, and how the data will be used to assess data accuracy, precision, completeness, comparability and representativeness. The QA reports that will be prepared semi-annually should report the data collected from the routine and non-routine procedures. These reports will give personnel within the network and data users an estimate of "how good" the reported APIOS data are.

This section will describe the types of procedures that are presently used by APIOS and others that could be implemented, in order that qualitative and quantitative reporting of the data could be carried out on a routine basis. The procedures will be described under each of the headings below.

Accuracy - Wet Deposition

Determining the accuracy of wet deposition data is very difficult for there is no accepted reference or true value with which the measurement system can be compared. In air quality monitoring networks accepted reference gases are available to quantify the accuracy of an instrument. These types of standards however do not exist for precipitation sampling.

While at this time it is not possible to determine the overall accuracy for precipitation sampling, it is possible to determine the

accuracy for some portions of the wet deposition sampling system. Work done by others (Vet, 1983) has shown how the sampling system can be broken down into its areas of inaccuracy or uncertainty (Figure 4.8.1).

The methods for determining the accuracy of various components of network operations, from figure 4.8.1, are described below.

A_L Determination of Accuracy of the Laboratory System

The determination of accuracy of the laboratory handling and analysis of samples is the responsibility of the laboratory quality assurance programme, and will not be discussed in this report. The laboratory accuracy estimates should be reported to the APIOS QA co-ordinator for inclusion in the semi-annual QA reports.

$A_{F/L}$ Determination of Various Components of the Field Operations and Laboratory System

The type of measurements used to assess inaccuracies in the field and/or laboratory system include:

Composite Samples (presently carried out by APIOS) - cumulative precipitation collected by the lab and shipped to the sites to be poured into a prepared sample bag as per routine APIOS procedures (for details, see APIOS Technical and Operating Manual). The procedure is

FIGURE 4.8.1

Areas of Uncertainty Covered by Specific Accuracy Measurements

Source of Variability		Areas of Uncertainty Covered by Specific Measurements
Precipitation		
Sample Handling	- Instrumentation	A_o
	- Operator Handling	A_{SP}
	- Sample Storage	$A_{F/L}$
Sample Shipment		
Laboratory Handling and Analysis		A_L

A_o - Accuracy of the overall system. Due to the lack of reference standards for precipitation, this accuracy is not yet measureable.

A_{SP} - Accuracy affected by operator handling, storage, shipment, and laboratory handling and analysis of the sample. This cannot be determined by routine operating procedures but requires a special study.

$A_{F/L}$ - Accuracy affected by operations after the sample has been collected in the instrument.

A_L - Accuracy of the analytical technique(s) being used to analyse the samples.

carried out semi-annually for cumulative samples and quarterly at event sites. The resultant data will provide the best available estimate of the accuracy of the sample handling, storage, shipment and analysis components of the wet deposition sampling system.

Note: Past experience has shown that the chemical stability of composite precipitation samples may be questionable. This should be verified (through Special Study) in order that there be confidence in the method. Any variability of the composite samples should be reported in the QA reports along with the accuracy determination.

Sample Handling Blanks (presently carried out by APIOS) - the same method and frequency as that described above should be carried out using deionized, distilled water instead of composite precipitation. This type of sample would have greater sensitivity than a composite sample (due to suspected composite variability) and is a test solely for detection of sample contamination (not leaching or possible biological activity). The resultant data should be published along with the composite sample data.

Field Blanks - Only for Event Sampling (presently carried out by APIOS) - this type of blank is very similar to the sample handling blank except that the distilled deionized water is added to an event sample bag that was exposed for a day or more but did not collect any precipitation. This blank provides information on the possible contamination of samples through dry deposition.

A_{SP} Determination of Accuracy by Special Study

The on site monitoring of precipitation through use of a mobile laboratory can provide valuable information on semi-immediate analysis of precipitation. It does not contain the inaccuracies that are introduced due to sample handling, storage, shipping, etc., and would therefore be helpful in quantifying many sampling inaccuracies. It should be carried out in conjunction with on site sampling and the two sets of results compared for differences in sampling accuracy.

The auditor realizes that this type of monitoring would only be possible if appropriate financial and manpower resources were available.

Accuracy of Dry Deposition

Methods discussed elsewhere (Bardswick, 1983a) for calibration of the sample volume recording system will provide the accuracy that can be expected by the sampling instrumentation. In order to determine the accuracy of the filter sampling head, it would be necessary to prepare a standard gas and allow the filter packs to sample from the gas stream

for a period of time. The cost and time for this would be quite extensive and beyond the range of this audit. It is suggested instead that as for wet deposition, procedures be carried out to determine the uncertainties in the filter sampling system. The types of procedures are described below:

Handling Blank or Filter Blanks (presently carried out by APIOS). The procedures described in the Technical and Operating Manual involve submitting filter blanks from each "lot" of filters used. Handling blanks are technologist loaded filter packs that are not exposed and unloaded along with the regular samples (see Section 4.2). The resulting analyses give a good estimate of inaccuracies due to filter handling, storage and impurities and should be reported in the semi-annual QA reports.

Precision - Wet Deposition and Dry Deposition

Precision is the agreement between individual measurements of the same property. Each of the various components within deposition monitoring will contribute to the scatter or variance of the results. The overall precision can then be determined as the sum of the variances of those individual components (variance, rather than standard deviation, has been used to describe precision because variances are additive while standard deviations are not).

For data reporting, what is required is to know variability (precision) of the whole system, while for QA, it is desired to understand the variance of the individual components of the system, so that those components with larger variance may receive higher levels of quality assurance. The types of measurements used to determine precision are described below.

Along with accuracy, estimates of data precision should be included in the QA Reports.

Overall Precision - Total Variance (presently being carried out by APIOS). The use of colocated instrumentation on sites is the best way to determine the overall precision of the measurement system. The differences determined from the pairs of data collected by the co-located instrumentation should be summarized for each co-located site. Variability in the precision between different sites should be reported along with variability between instrument pairs. Because precision may vary from site to site, it is recommended that every six months the colocated instrumentation be moved to a new site.

Variability Due to Field and Laboratory Procedures. In order to determine the variability due to operator sample handling, shipping, storage and laboratory analysis, a procedure can be carried out to exclude the variability due to instrumentation and the lack of homogeneity of wet or dry deposition.

This can be done by operators splitting a sample periodically into two equal parts and submitting both for analysis. For dry deposition samples, the filter should be cut with a cleaned knife into two parts and both submitted separately for analysis. For wet deposition samples, the cumulative sample bag can be sealed according to normal procedure and then a seal made in the middle of bag splitting the sample in two. For events, samples the bag can be decanted into two separate bottles. (Note: in order to avoid sample inhomogeneity, samples should be shaken before decanting.)

Variability Due to Laboratory Analysis. Variability determination in the laboratory is not covered here, but would include such procedures as within-run duplicates, between run splits and analyst to analyst repeats. As with accuracy laboratory variability should be reported by the lab periodically and their information included in the APIOS QA reports.

Completeness of APIOS Data

With the APIOS data screening and validation procedures, questionable data are qualified using various sample flagging procedures. This means that while questionable data are flagged, no decision is made as to whether the data are valid or not. The APIOS objective in doing this is to let the eventual data user decide from the qualifying

comments whether the data are valid or not for his or her intended purpose.

In determining completeness for the APIOS data, it is necessary to establish some guidelines for what valid data are. This does not mean that invalidated data need be excluded from the data set; they should, however, be flagged as not valid data for APIOS Data Guidelines. The QA co-ordinator and Database scientist should set these guidelines prior to data completeness guidelines being set.

After the validation guidelines have been set and the validating of data included in the validation procedures, then completeness objectives may be established. Using these objectives, the QA co-ordinator will determine on a periodic basis if the existing QA procedures are sufficient to satisfy the completeness requirements of APIOS.

In setting completeness objectives it is not sufficient to say, for example, that 80 % of all data are valid. Instead, two factors must be considered:

1) the type of collected data set (semi-annual, seasonal, monthly or daily) that is being presented;

2) the period for which data are being analysed (annual, semi-annual, seasonal or monthly).

FIGURE 4.8.2

Data Completeness Objectives for APIOS Data

Period to be Analysed \ Collected Data Set	Semi-Annual	Seasonal	Monthly	Daily
Annual	2/2	4/4	8/12	80%
Semi-Annual		2/2	4/6	80%
Seasonal			2/3	80%
Monthly				80%

Note: for cumulative samples, omit the last column.

Comparability of APIOS Data

Comparability is becoming increasingly important as deposition monitoring networks pool data into large data bases. Both routine and non-routine procedures can be used to assess the data comparability.

Most routine procedures for assuring comparability, such as the use of standard units (mgl^{-1} or $\mu g\ m^{-3}$), determination of quality assurance parameters (ion balance, predicted or measured, pH and conductivity, etc.), flagging of data, standardized instrument response and sizing (senior resistance, sampler delay time, orifice size, flow rate, etc.) are presently carried out by APIOS. A summary of these routine procedures should be included in the semi-annual QA report.

Most of the suggested non-routine procedures for assuring comparability, such as interlaboratory round robins, co-locating sampling sites with other networks and an annual review of APIOS sites and siting criteria in order to assure comparability with other networks are presently carried out by APIOS. This has led to good comparability of APIOS data with standard procedures and other monitoring networks.

The routine and non-routine procedures to ensure data comparability should be included in the QA Manual.

and office comments kept for each site as a good indicator of the representativeness of samples being collected.

A summary of data representativeness should be included in the semi-annual QA Report.

Many of the routine and non-routine procedures, mentioned in this section, for assessing data accuracy, precision, completeness, comparability and representativeness are already carried out by APIOS. This is a good reflection of the importance that network management ascribes to quality assurance. It is equally important that these procedures be fully documented and the results reported on a periodic basis. The forthcoming QA Manual and semi-annual QA Reports will satisfy this need and should be given a high priority in future network tasks.

4.9 APIOS Organizational Structure

The APIOS Organizational Structure is described in the Technical and Operating Manual (Bardswick 1983a) and details the responsibilities of each of the various positions within APIOS.

During the site and technologists audit, it became obvious that while the technologists were doing a good job, due to time constraints, they were not able to carry out all the duties that they

are responsible for. As explained in the manual, the regional technologists' general responsibilities include:

1. Installation, operation and maintenance of monitoring networks.

2. Liaison with network operators.

3. Execution of special studies as required.

Examples can be given for all three of the general responsibilities above, where the technologist does not have sufficient time to carry out tasks which the technologist is responsible for.

An evaluation of the technologist's time requirements for fulfilling their responsibilities was made and a possible reorganization of tasks prepared to allocate the technologist's time in the best way possible. At the request of the APIOS QA co-ordinator, this evaluation is included here:

Proposed Technologist Task Reorganization (assumes 8 cumulative and 4 event sites)

Task 1) Site Visits to Cumulative Sampling Sites

- carried out once per season (every 3 months);
- would include a more comprehensive check of operator and instrument performance (integrated with audit and training systems);
- would include preventive maintenance checks and seasonal adjustments (levelling, instrument cleaning, changeover procedures);
- in the months that technologists do not visit sites, samples would be shipped to regional offices (requires shipping containers, bag sealing devices and co-ordination of courier pick-up service).

Proposed Time Requirement	~2.5 days/month
Present Time Requirement	~5 days/month.

Task 2 Site Visits to Event Sampling Sites

- carried out once every two weeks;

- visit 2 of the 4 sites each week and the other two sites the second week;

- samples to be refrigerated on site until pick-up by technologist.

Proposed Time Requirement	~4 days/month
Present Time Requirement	~8 days/month

Task 3 Handling of Cumulative and Event Type Filters

- procedure should remain the same.

Present and Proposed Time Requirement	~4 days/month.

Task 4 Sample Handling

- telephone checks with operators;

- preparation of field sheets;

- sample pHs;

- sample storage and shipping.

Present and

Proposed Time Requirement ~2.5 days/month

Task 5 Routine Instrumentation Overhaul

- overhauling of Low-Vol, Sequential Sampler, Aerochem Metric, Sangamo/M.I.C.;

- Inventory Control (spare parts).

Present and

Proposed Time Requirement ~1 day/month

Task 6 On Call Servicing

- instrument breakdown;

- operator's sick leave.

Proposed Time Requirement ~1.5 days/month

Present Time Requirement ~2 days/month

Task 7 Routine QA Procedures

- QA samples;
- monthly summaries;
- internal audits;
- screening data.

Proposed Time Requirement	~2 days/month
Present Time Requirement	~1.5 days/month

Task 8 Regional Office Administration

Present and Proposed Time Requirement	~1 day/month

Task 9 APIOS Administration

- meetings at Air Resources Branch (ARB);
- site visits by ARB personnel.
- other ARB business

Present and Proposed Time Requirement	~1 day/month
Total Proposed Time Requirement	~19.5 days/month
Total Present Time Requirement	~26 days/month

The average total number of working days in a month is 22. It can be seen above that typically the present time requirement for regional technologists is 26 days per month, 4 days more than what is available. The proposed system would drop the monthly time requirement to 19.5 days per month, allowing some time (2.5 days) for special studies and contingency.

It is believed that the proposed reorganization can be adopted at this time for a number of reasons, as presented below:

- The operation of the network has stabilized enough so that operator and technologist have developed good working relationships. In the early stages of the network, it was necessary to maintain close contact between operator and technologist to ensure that operating procedures were followed correctly.

- The additional preventive and routine maintenance carried out during seasonal cumulative site visits should improve instrument reliability and performance.

- Allowing the necessary time to be spent on quality control procedures (especially important once QA Manual is prepared) would assure the production of high quality data.

- In order to maintain good technologist morale and to carry out the special studies that will help quantify estimates of accuracy and precision.

In order to institute the proposed reorganization, it will be necessary to provide the operators with a means of sealing sample bags, a suitable sample shipping container and a regular courier sample pick-up service. The regional technologist, not the operator, should assume responsibility for co-ordinating the courier service. The technologist should also liaise monthly with the operators regarding sample change, sampler malfunctions, supplies requests and sample pick-up dates.

It is believed that adoption of the proposed (or similar) reorganization will result in improved field operations and data quality overall, and so should be adopted as soon as is feasibly possible.

4.10 Outstanding Recommendations from the 1982 Audit

In the Phase I Audit Programme (Concord Scientific Corporation, 1983b), action taken on the recommendations from the 1982 audit (Concord Scientific Corporation, 1982) were discussed. In some cases, no action was taken. Some of the recommendations will not be acted on for APIOS personnel do not feel that the action item is required or pertinent or that additional action should have been taken. These cases will be noted in this section along with some other reported action items that did not truly reflect the course of action taken by APIOS. These are discussed below:

Network Representativeness Recommendations

1. One possible way to assess the impact of poor siting on data collected would be to establish additional, properly sited instruments near the existing monitors. If no significant differences are observed, it may be possible to maintain the data collected from original samples with qualification, and thereby collect uninterrupted data at one site.

Action Taken:

No action has been taken and none is planned due to budgetary and manpower constraints. Sites will be evaluated by looking at the data and also comparing site data to nearby sites (as described in Section 3).

Recommendations Regarding Cumulative Precipitation Sampling

1. The regional technologist should visit the sites as often as possible (at least every two months) to perform operator training and instrument service.

Note: One of the recommendations from the findings of the Phase I Audit suggest a reorganization of technologist responsibilities so that site visits are not required as frequently.

Action Taken:

Still a problem due to heavy workload and large distances between sites. A reorganization of technologists' time allocation is presently under review by network management (a new technologists' time allocation is presented in Section 4.9).

2. Instrument and site log books should be redesigned to ensure that all relevant information is passed to the QA co-ordinator, so that it may be used for data validation and interpretation.

Action Taken:

New log books are used, the use of the collected data should be described in the upcoming QA Manual.

3. The storage gauge measurement for precipitation amount determination should be evaluated. In particular, a new method should be developed for determining the depth. The collection efficiency during winter should be investigated, and more attention should be paid to standardizing the gauge height and ensuring that it is level. Co-located storage gauges should be employed at a number of sites to examine the precision of the storage gauges and measurement techniques.

Action Taken:

Storage gauge measurement has been compared to standard rain and nipher shielded gauges. The comparisons indicated close agreement between the measurement methods. New procedures have been implemented to increase instrument reliabiity (Bardswick 1983a). Co-located storage gauges have also been installed at some sites.

4. Continued design work is required with respect to the modifications to the Sangamo/MIC sampler. The following areas should be addressed:

- a knife edge collar should be designed for the winter buckets to eliminate the gap problem;

- a system should be designed to improve bag fit by pulling the bag down into the bucket and forming a proper shape at the orifice;

- the cause and prevention of leaks in the bags should be investigated. Until a solution is found, the sample volume should be determined in the field and the sample bags should not be used as the sole shipping container.

Action Taken:

A new knife edge collar is used (with no gap). A new system is used to improve bag fit (Bardswick 1983a), however, the fit is still poor, as seen in the Phase Audit (Section 3.2). Recommendations to improve bag fit are described elsewhere in this report (Section 4.3). A new bag is being used that should greatly decrease the occurrence of leaking bags.

Event Precipitation Sampling Recommendations

1. The Nipher shielded gauge sampler should be evaluated. The stand should be redesigned for safety and height adjustment

(if desired). Caps should be considered for use in melting the collected samples at room temperature.

Action Taken:

Stands where necessary have been reinforced. Caps for the gauge during melting are required to prevent evaporation and spillage.

Air Sampling Recommendations

1. Duplicate air sampling should be carried out at a minimum of one location for each type of sampling to provide a measurement of precision.

Action Taken:

A co-located event dry deposition sampling head has been installed at Dorset. Co-located Low-Vol samplers have been installed at one site in each region.

2. The volume measurement on all air sampling equipment should be calibrated on a regular basis (at least twice per year) and the calibration factor should be applied to the raw volume data before reporting.

Action Taken:

Calibration procedures have been developed (Bardswick 1983a), but calibration factors are not yet applied to reported data.

General Recommendations

1. Data screening and validation programmes should be developed and documented for all types of network data as quickly as possible.

Action Taken:

Done for Event/Wet and Cumulative/Wet and Event/Dry but not yet for Cumulative/Dry data.

2. The configuration of all instrumentation should be standardized across the network. In particular, the height of the orifices above the ground should be standardized for all collectors and gauges.

Action Taken:

Heights of collectors or gauges have all been standardized except for storage gauge (Bardswick, 1983a).

It should be noted that for most of the 40 recommendations from the 1982 audit action has been taken that will work towards improving the quality of data produced by APIOS.

5. RECOMMENDATION SUMMARY

This chapter is a point by point summary of the recommendations made in this report in the order in which they appear (except in the case of the recommendations regarding the QA Manual, as these recommendations are from various parts of the report). For additional information on any recommendation, the section where it first appears is given in brackets. Action should be taken immediately on any recommendation that is identified by an asterisk (*), because there is a good chance that these items may have significant effect on present data quality. The other recommendations should be acted on as soon as possible.

1. *Corrective action at audited sites (Section 3.1, Appendix II).

2. *Review of marginal or poor siting or operations by QA Co-ordinator (Section 3.1).

3. Feedback to operators on APIOS Monitoring Networks (APIOS QA Plan, Section 3.1).

4. *Update and upgrade training for operators (Section 3.1).

5. *Technologists to review APIOS Technical and Operating Manual with Operators (Section 3.1).

6. Detailed specifications of instrument checks for Aerochem, Sequential Sampler and Low-Vol Sampler (similar to Sangamo/MIC type checks) (Section 3.1).

7. Sangamo/MIC sensor resistance and clutch setting should be set more often by technologists (Section 3.1).

8. *During winter months, snow and ice should be cleaned off the instrument housing of the Sangamo/MIC and Aerochem (Sections 3.1 and 4.2).

9. Operators should be instructed by technologists on how to keep on-site log books (Section 3.1).

10. Incorporate log book recorded information into data screening and validation procedures (Section 3.1).

11. *Technologists should review filter handling procedures (especially those that could provide a potential contamination; type of tweezers, washing of filter packs) (Section 3.2).

12. Technologists should carry out routine calibration and maintenance of instrumentation (as described in APIOS Operating Manual and Section 3.2).

13. *Technologists should minimize the exposure time of all precipitation samples, event and cumulative, to temperatures above 4°C (Section 3.2).

14. *Technologists should alert head office of site changes as described in the Technical and Operating Manual (Section 3.2).

15. Head office should have an upgrading training session for APIOS technologists (Section 3.2).

16. *Technologists should not park vehicles near samplers. If a vehicle must be brought close to the sampler location, it should never be left running (Section 3.2).

17. Operator Sheets should be compared with Field Sheets periodically by QA Co-ordinator for errors in data transfer (Section 3.3).

18. Field Sheets should be checked periodically against data base for errors in data transfer (Section 3.2).

19. QA Co-ordinator should periodically verify that technologists are carrying out storage gauge depth determination correctly (Section 3.2).

20. Technologists should be made aware of deviations in sampling dates and times at their sites. Where possible, operators should be requested to follow the specified APIOS sampling dates and times more closely (Section 3.3).

21. *The QA Co-ordinator should review sample data (including comments and collection efficiencies) for the cumulative sites Gowganda, Moonbeam, Attawapiskat, Ear Falls and Pickle Lake. It was noted during the data audit for the cumulative network that the quality of data being collected at these sites are questionable (Section 3.3).

22. In order to gear operating procedures to the intended user, a restructuring of the APIOS Technical and Operating Manual into an Operator, Field Operations, Instrumentation and Laboratory Operations Manual should be considered (Section 4.1).

23. *Preparation of the QA Manual (Section 4.1), to include:

- details of the contents of QA reports;
- scheduling and frequency of instrumentation calibration and maintenance;
- initial and upgrading training programmes for operators and technologists (Sections 4.1 and 4.6);

- corrective action system (Sections 4.1 and 4.6);
- routine and non-routine QA procedures to assess data accuracy, precision, completeness, comparability and representativeness (Sections 4.1 and 4.8).

24. Instrumentation servicing procedures for both operators and technologists, including a troubleshooting guide, should be included in an instrument manual (Section 4.1).

25. *The method currently used to fit sample bags into sampler buckets should be discontinued and another method adopted (Sections 4.2 and 4.3).

26. Storage procedures for cumulative precipitation samples for operators and technologists should be developed and included in the operating procedures (Section 4.2).

27. Filter handling blank procedures should be modified to include all potential contamination areas (Section 4.2).

28. A schedule detailing which samplers and gauges are to be used at each monitoring site during different times of the year should be included in the operator procedures (Section 4.2).

29. Consideration should be given to changing the orifice diameter of the various collectors and gauges to reflect an orifice diameter equal to the diameter of the container measured across the orifice opening from the midpoint of the gauge or bucket wall (Section 4.3).

30. *Modifications should be made to the Sangamo/MIC sampler to improve reliability, operation and performance, and to allow standardization of instrument performance (Section 4.3).

31. *Modifications to the Aerochem Metric sampler to improve sensitivity and reliability especially during winter months (Section 4.3).

32. Modification of the Metrex Sequential Sampler's flowmetering system, including an accumulated time counter (Section 4.3).

33. Replace Metrex Low-Volume Sampler pumps with a more reliable pump (Section 4.3).

34. Replace the storage gauge winter solution with an immersion heater in water (Section 4.3). Standardize storage gauge orifice height (Section 4.3).

35. Reinforce Nipher shielded gauge support stand (Section 4.3).

36. *Provide operators with caps for the Nipher shielded gauge collection vessel (Section 4.3).

37. All sites should have GFIC's on 115 VAC supply line (Section 4.3).

38. On site receptacles should have a cover (Section 4.3).

39. APIOS siting criteria should be added to in the following areas (Section 4.4):

- no objects within 5 meters of a sampler;
- sites located in agricultural areas should have a windbreak for 360°;
- windbreaks on site are very desirable especially in the prevailing wind directions;
- due to their effect on airflow buildings should be located if possible 4 to 5 heights away from the sampler;
- on site pollutant sources (e.g., woodburning stoves) should be avoided;
- windbreaks should be located in between roads and the sampler.

40. *APIOS should develop a formalized corrective action system (Section 4.5).

41. APIOS should develop a formalized training programme for new APIOS network personnel and also a programme to update and upgrade existing personnel (Section 4.6).

42. Additional manual data checking should be carried out by technologists and the QA Co-ordinator (Section 4.7) as follows:

- comparison of the operator and field sheets for correct data transfer;
- manual spot checking of the calculated storage gauge depth;
- the technologist and QA Co-ordinator should keep a running record of field comments and instrument malfunctions at each site to spot adverse trends that could affect data quality;
- the field technologist should be given copies of the qualifying remarks appended to samples during computerized data screening so that site records and technologist records may be checked and the potential effects leading to the qualifying comments may be documented as part of the sample history.

43. Upper and low limits of integrity checks for screening cumulative data are determined from historical event data. It should be

REFERENCES

Bardswick, W.S. 1983a: "APIOS Technical and Operating Manual". Ontario Ministry of the Environment, Air Resources Branch, April 1983.

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MOE, 1983: "Monthly 28 Day Cumulative Precipitation Chemistry Lists, June 1980 - December 1982". Ontario Ministry of the Environment report, ARB-53-83-ARSP.

US EPA 1976: "Quality Assurance Handbook for Pollution Measurement Systems. Volume I - Principles". U.S. Environmental Agency - EPA-600/9-76-005.

GUIDELINES FOR THE COMPLETION OF
"MOE SITE DESCRIPTION QUESTIONNAIRE"

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
1	I	Site Identification	1-8	Self-explanatory
1	I		9	Park, government facility, private property, climat site, institution, conservation area
1-2			10-14	Self-explanatory
2			15	Modified Sangamo/MIC, Aerochem Metrics, Nipher, Standard rain gauge, Storage gauge, Low-vol, Metrex sequential, Fisher-Porter Rain gauge Precipitation chemistry, standard precipitation depth, air quality, meteorological
3	II	Site Details	1	Forest clearing, open area, field
3			2	Flat, hill, sloping, bowl
3			3	Self-explanatory
3			4	Grass, grain, soil, sand, moss, rock, gravel
3	II	Site Details	5	Self-explanatory
3			6	Walk, car, 4-wheel drive, snowmobile, snow shoe
3			7	Self-explanatory
3			8	Coniferous trees, deciduous trees, wires, poles, fences, towers. Building height above sampler not above grade
3			9	Distance, direction, general description of area as well as typical heights of snow or amount of dust

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
3				Self-explanatory
4			11	Land use: cultivation, orchard, crops, pasture, forest, water, livestock, garden Ground cover: grass, shrubs, gravel, soil, sand, moss, rock
4			12	Describe any physical changes to site or surrounding area anticipated, i.e., new buildings, new industry, new pollution sources, new roads, new road surfaces, new gardens, new poles or wires, cut trees or exposed earth, etc.
4			13	Locked gate, guard dog, flooding in spring, large snow drifts
4			14-17	Self-explanatory
5	III	Site Influences	1	Self-explanatory
6			2	Access roads, paved roads, unpaved roads, parking lots, garages, major highways within 5 km
6			3	Lakes, rivers, railroads, airports, canals
7			4	Cultivation (specify crop type), orchards, pasture, grazing, trees
7			5	Local: sewage lagoons, salt/sand piles, gardens, gravel pits, marshes, livestock, exposed earth, oil/gas wells, construction activity

PAGE #	SECTION #	NAME	ITEM	GUIDELINES
				Area: Power plants, heavy industry, light industry, open pit mines, foundaries, mines, saw mills, pulp & paper plants within 50 km
8			6	Towns within 5 km, important reference points, major urban centres within 50 km and special notes for large urban/industrial centres (e.g., Toronto)
8-9			7-9	Self-explanatory
10-11	IV	Site Diagram	1	Use symbols as indicated in legend
12		Topographical Map		Attach a section of the most appropriate topographical map which shows the APIOS site and surrounding area
13		Aerial Photograph		Attach a section of the most appropriate aerial photograph which shows the APIOS site and surrounding area
14		Site Photograph		Include photographs from the four compass points with the sampler in the foreground

INFORMATION SOURCE DESCRIPTION

FOR: MOE SITE DESCRIPTION QUESTIONNAIRE

SECTION	QUESTION	SOURCE
I SITE IDENTIFICATION	1, 2	Operator/Regional Technician
	3, 4	Auditor
	5	Operator/Regional Technician
	6	MNR/Road or District Map
	7, 8	Topographical Maps
	9	Operator/Auditor's Observations
	10	Operator
	11	Regional Technician
	12	QA Manager/Regional Technician
	13	Operator
	14	Auditor/Operator
	15	Auditor Visual Inspection
II SITE DETAILS	1, 2, 3, 4	Auditor's Observations
	5, 6, 7	Operator
	8	Auditor's Observations
	9, 10	Operator
	11	Aerial Photograph
	12	Operator
	13	Operator/Auditor's Observations
	14	Operator
	15	Operator/Auditor's Observations
	16	Auditor to measure with tape
	17	Operator
III SITE INFLUENCES	1. On Site Observation	Auditor's observation - to be measured with a tape
	1. Local Area Sources	Operator
	2, 3, 4, 5, 6	Operator

INFORMATION SOURCE DESCRIPTION

FOR: MOE SITE DESCRIPTION QUESTIONNAIRE

SECTION	QUESTION	SOURCE
III SITE INFLUENCES (cont'd)	7	Auditor observation and information obtained from topographical map
	8,9	Operator's Observation

LEGEND OF SYMBOLS FOR USE IN SITE DRAWING

Building	Aerial Cable
Primary Sampler	Prevailing Wind Direction
Low Vol	Railroad tracks
Storage Gauge	Poles
Nipher Guage	N North
Roads	Fence
Brush	H- Height
Coniferous Trees	Stevenson Screen
Deciduous Trees	
Sloping Ground	

Concord Scientific Corporation

MOE SITE DESCRIPTION AUDIT QUESTIONAIRE

I SITE IDENTIFICATION

1. Station Name: ______________________
2. Station Number (SIS) ______________________
3. Date of Visit: ______________ Time: ________
4. Auditor: ______________________
5. MOE Region ______________________
6. County: ______________ Townwship: ______________
7. Latitude ___° ___' ___" Longitude: ___° ___' ___"
   UTM Co-ordinates ______________________
8. Elevation ______________ m
9. Type of Site (park, gov't facility, private property, etc):
   ____
10. Site Address ______________________
    ____
    ____
    Mailing Address ______________________
    (if different ______________________
    from above) ______________________
11. Brief description of how to reach site
    ____
    ____
    ____
12. Name of Primary Operator ______________________
    Alternate Operator ______________________
    Regional Technician ______________________
13. Operators Address ______________________
    ____
    ____
    Mailing Address ______________________
    (if different ______________________
    from above) ______________________
    Telephone Number Home ( ) - ______ Business ( ) - ______
    Alternate Operator Home ( ) - ______ Business ( ) - ______

MOE SITE DESCRIPTION AUDIT QUESTIONAIRE (Cont'd)

14. Sample Types Collected at Site:

Cumulative Wet_______________ Cumulative Dry __________

Event Wet___________________ Event Dry________________

Other (describe)_____________ Special Study____________

15. List monitoring instrumentation on site.

Instrument Type/Make	Measurement

II SITE DETAILS

1. Physical characteristics of site (i.e. clearing, open area):

   ____

2. Site Topography (e.g. flat, hilly, sloping):

   ____

3. Ground slope at site: ______________________________

4. Ground cover at site: ______________________________

5. Access to site Summer: Good ____ Fair____ Poor____ N/A____

   Winter: Good ____ Fair____ Poor____ N/A____

6. Method of access: Summer: ___________________________

   Winter: ___________________________

7. How close do vehicles normally approach sampler?

   ____

8. Presence of windbreaks within 100m of sampler:

Type	Height (m)	Distance (m)	Direction

9. Where do snow and dust drift and accumulate?:

   ____

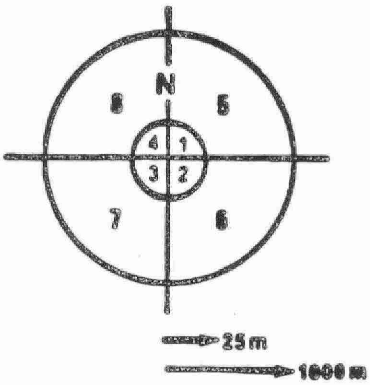
10. Prevailing wind direction during precipitation?:

    Winter: ______________________________________

    Summer: ______________________________________

II SITE DETAILS (continued)

11. Land Use:



	Land Use	%	Ground Cover	%
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

12. Future land use, planned or expected (construction, new cultivation, clearing, etc): ______________________

13. Are there any logistical problems which prevent the sampling site from being easily approached or operated (locked gate, guard dog, flooding in spring, large snow drifts): ________

____

____

14. What is the electrical power available at the site?

_______(volts)_________(Amps)__________(# of circuits)

15. Is the circuit on a:

Receptacle GFIC ____________ No GFIC ______________

Circuit Breaker GFIC __________ Battery ______________

16. Distance from collector receptacle to circuit panel: ______m

17. What are the number of power failures:

per month___________ per year ___________

III SITE INFLUENCES

1. General potential sources of contamination/interferences

Type	HEIGHT(m)/ SIZE	DISTANCE (m)	DIRECTION
On-Site Obstructions Trees			
Poles			
Wires			
Buildings			
Other -			
Local Area Sources (within 5Km) Sewage Lagoons			
Salt/Sand Piles			
Gardens			
Gravel Pits			
Marshes			
Live Stock			
Exposed Earth			
Oil/Gas Wells			
Construction			
Human Activity			

III SITE INFLUENCES (continued)

2. Vehicle Related

TYPE	NAME	SURFACE/ USAGE	DISTANCE(m)/ DIRECTION	SNOW/DUST CONTROL
Highways				
Paved Roads				
Unpaved Roads				
Access Roads (Driveways)				
Parking Lots				
Garages				

3. Other Transportation-Related Influences

TYPE	NAME	DISTANCE(km)/ DIRECTION	USAGE	COMMENTS
Lake				
River				
Rail				
Airport				

III SITE INFLUENCES (continued)

4. Agricultural Activities

TYPE	AMOUNT	DISTANCE(km)/ DIRECTION	HERBICIDES/ PESTICIDES

5. Local and Area Pollutions Sources

TYPE	NAME	DISTANCE(km)/ DIRECTION	CAPACITY/ PRODUCT	EMMISSION TYPE/RATE

III SITE INFLUENCES (continued)

6. Population Centres

NAME	DISTANCE(km)	DIRECTION	POPULATION

7. Is the site representative of the topography and vegatative ground cover within the surrounding area? (10 - 100 km)

____

____

8. List deviations from siting criteria and all advantages and disadvantages of site: ______________________

____

____

____

____

____

III SITE INFLUENCES (continued)

9. Auditor's comments with respect to site (Is it a excellent, good, fair, poor unacceptable site?): ______________________

____

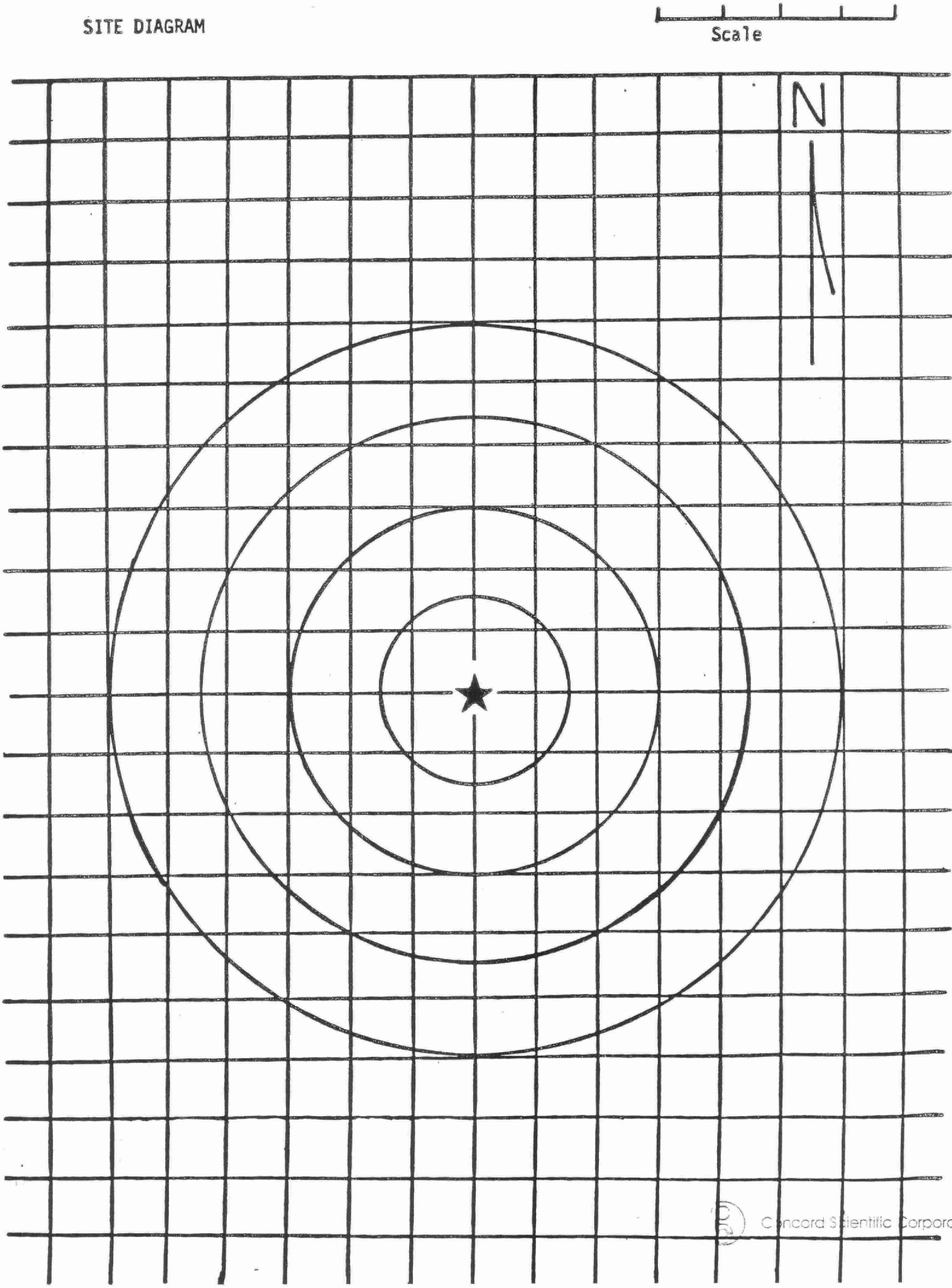
____

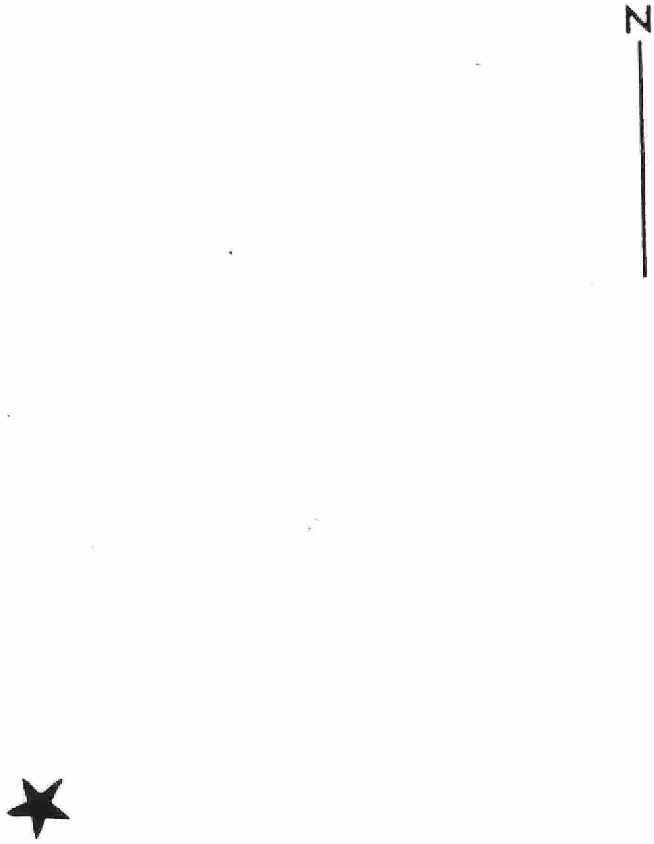
____

____

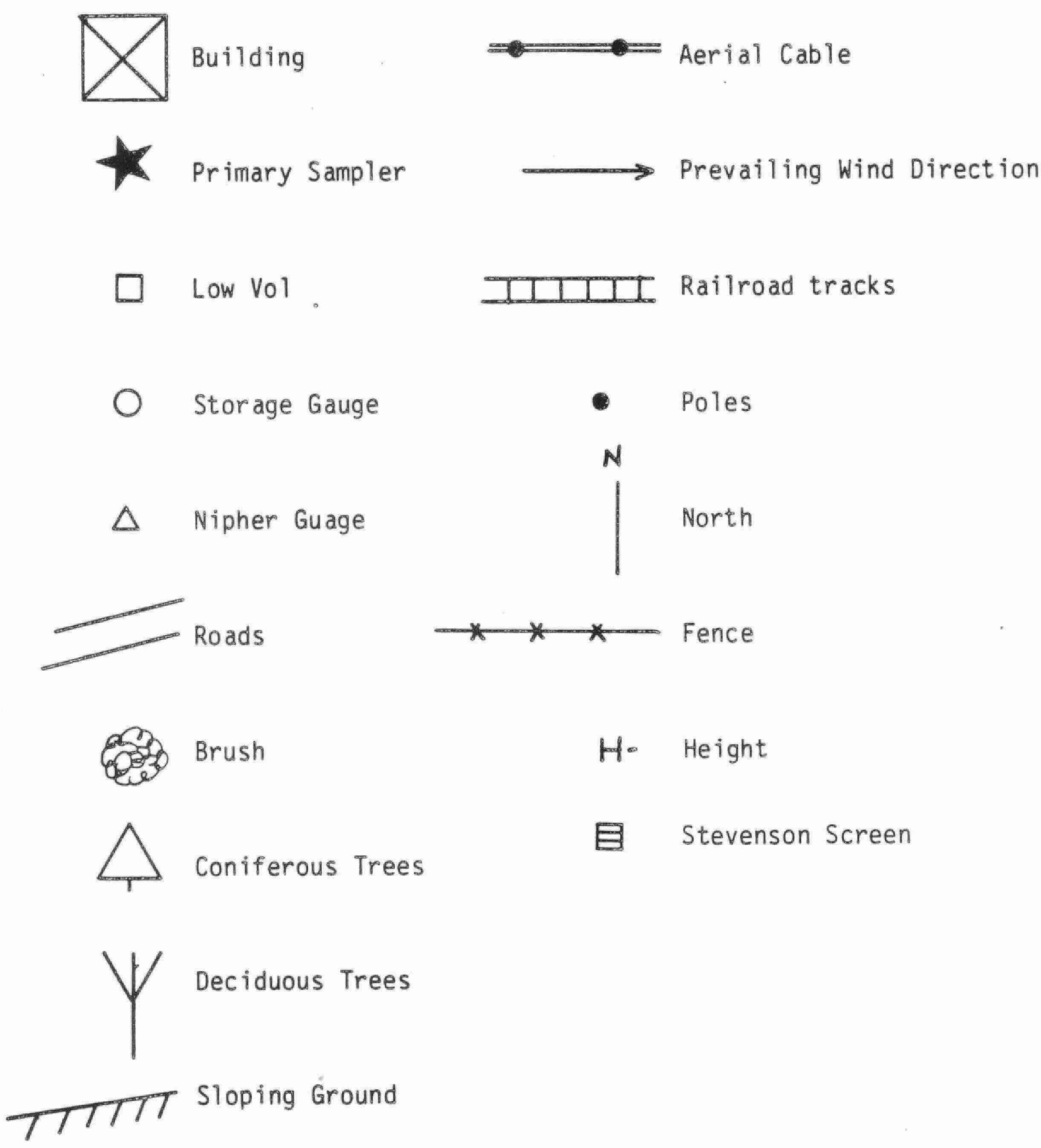
____

SITE DIAGRAM




N

LEGEND OF SYMBOLS FOR USE IN SITE DRAWING



Topographical Map

Areal Photograph

Site Photographs

TYPE OF MONITORING - CUMULATIVE WET

INSTRUMENT - MIC Collector (Formerly Sangamo Type A - Modified)

Configuration Checks (Record results on "MIC/Sangamo Type A Data Sheets")

1. Ensure gasket on cover contacts knife edge all the way around, especially on farthest position of sampler cover.

2. Ensure sample bag fits container well.

3. Only galvanized support should be used.

4. Original steel U-bolts were to be replaced with stainless steel U-bolts.

5. Knife edge should be level across opening. Qualitatively test by placing clean plastic over open wet bucket with a level on top. Note whether it is level, slightly out of level or not level.

6. Inspect knife edge opening and measure gap.

7. Check that the underside of sensor grids is not blackened or discoloured.

8. Check that both grids are warm, not hot to the touch.

Calibration Checks (Record results on "MIC/Sangamo Type A Data Sheets")

1. Instrument Response - Using CSC Ohm Ranger find the resistance of the precipitation sensor necessary to activate the sampler. A resistance of 220 KΩ should cause the sampler to activate. (Figure 1).

2. <u>Heating of Sensor</u> - Measuring the voltage across the two heating terminals on the sensor a pulsing ACV of 5 volts should be detected. If the voltage is not pulsing there is an instrument problem. Test the heater by placing voltmeter probes across heater pins (Figure 2). The grids should feel warm to touch not hot or cold.

3. <u>Clutch Adjustment</u> - Activate and stop sampler midway by turning on and off switch. Place the hook of a spring gauge at the junction of a sampler arm and cover. Holding the other end of the gauge (ring) turn on sampler. The arm should start to move until the gauge reads 14 lbs at which point the instrument clutch should start to slip. Measure the clutch slip. (Figure 3).

4. <u>Limit Switch Adjustment</u> - Activate sampler and when sampler cover reaches midway turn off sampler and unplug from receptacle. Remove instrument screen and cover.
   a) Depress limit switch plungers (2x) until they click and then release. Switch plungers should spring back without sticking.
   b) Visually inspect switch plungers. Note any deformity of plunger.

   Plug sampler back into receptacle and turn sampler on observing angle of adjustment screw and limit switch plunger.
   c) Note if adjustment screw is contacting plunger on such an angle as to damage switch.
   d) Note if adjustment screw at end of travel is bending limit switch support bucket. (Figure 4).

5. <u>Gasket Seal on Kinife Edge</u> - Place a thin layer of clear compressable foam on the edge and allow sampler cover to move and compress foam will allow a check of gasket sealing ability. After a short interval activate sampler and inspect knife edge impression on foam. (Figure 5).

6. <u>Sampler Delay Time</u> - Short sensor with metal strip or moistened finger and start stopwatch. Stop stopwatch when sample cover starts to return to wet side of instrument.

FIGURE 1

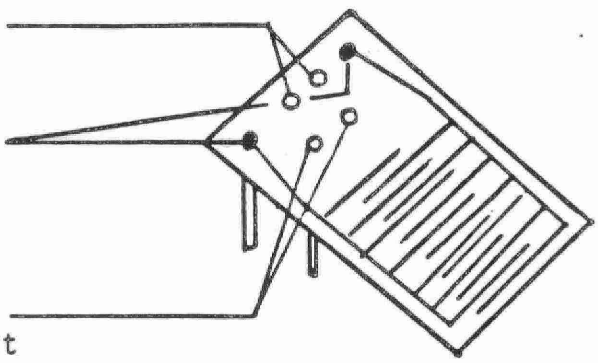


FIGURE 2

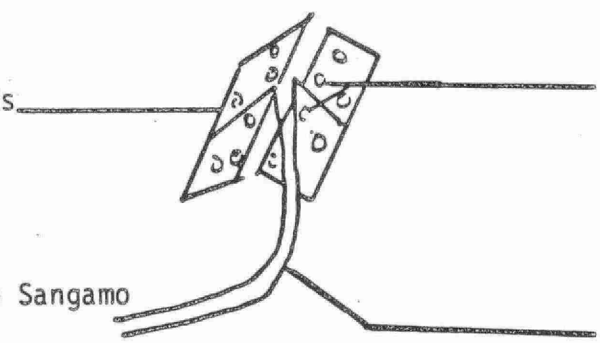


FIGURE 3

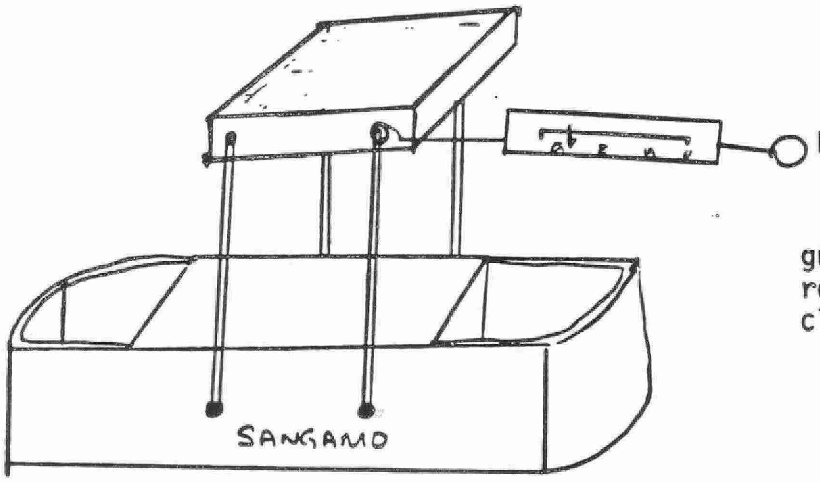
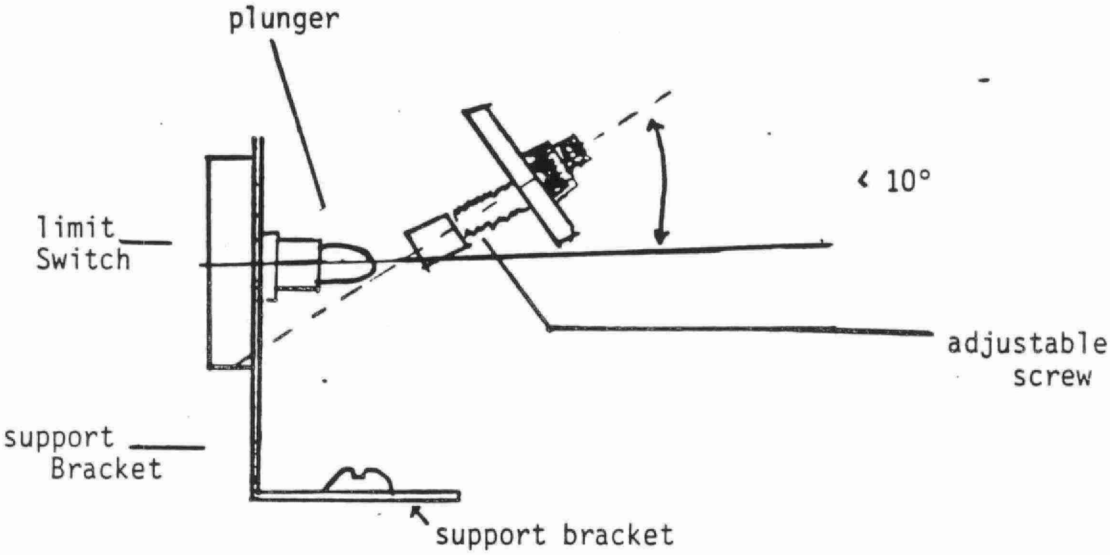
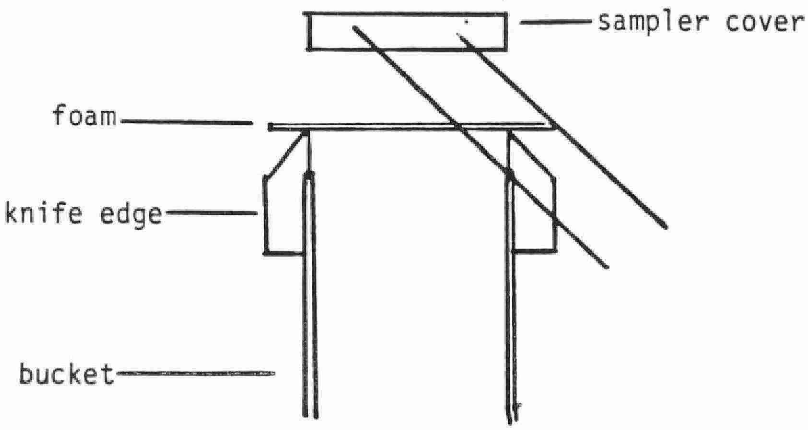


FIGURE 4


plunger
limit Switch
< 10°
adjustable screw
support Bracket
support bracket


sampler cover
foam
knife edge
bucket

MIC/MODIFIED SANGAMO TYPE A DATA SHEET

Site: ______________________________

Serial #: ______________ Model #: ______________

On Stand? ______________ Height above ground ______________

	N - S	E - W
	WET	WET
(Bucket) SAMPLE ORIFICE (cm)		
(Bag) SAMPLE ORIFICE (cm)		

Level ______________________________

Precipitation Sensor Checks

Knife edge gap ______________ mm

Instrument Response ______________ kΩ

Heating of Sensor ______________ volts

Warm to touch ______________

Delay Time ______________ sec

Clutch Adjustment ______________ lbs

pulsing? ______________

Blackened/Discolored? ______________

Comment on:

Limit Switch Adjustment: ______________________________

Gasket Seal on Knife Edge: ______________________________

Hood Movement: ______________________________

Bag Fit: ______________________________

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC

OPERATOR: ______________________________

SITE: ______________________________

Operator's Duties	Yes	No
1. What time does operator change sample bags? If he can't change at the proper time, what does he do? (phone technican, change bag when he can, contact alternate operator). ______________		
2. Does the operator, while removing the sample bag from the sample bucket, allow for any chance of contamination of the precipitation sample? Several points that may present contamination are:		
- is sample bucket removed from sampler prior to changing sample bag?	___	___
- does the operator wear clean, new gloves to remove the knife edge?	___	___
- does he handle <u>only</u> the outside of bucket and knife edge?	___	___
- is he careful not to contaminate knife edge when its taken off?	___	___
- is bag removed in such a way as to not introduce contamination from top and outside portions of bag?	___	___
- is operator careful not to stand directly over pail?	___	___
- is there a potential for contamination by hair, coat, etc.	___	___
Comments: ______________________________		

Operator's Duties	Yes	No
3. Are the sample bags properly handled to prevent damage, sample loss and allow for proper handling by laboratory staff? Several points should be checked:		
- is air forced out of bag before sealing?	___	___
- is bag tied near enough to the top so that it can be leached for metals analysis, but far enough down so that none of the contaminated surfaces are exposed to sample? How is bag tied and sealed? ______	___	___
- does operator use a container to store and transport sample? ______	___	___
- are bags promptly labelled (What information is recorded on label)? ______	___	___
- for winter operation with long tube how is bag removed? ______		
- where does operator store sample for pick up by technician? (winter and summer). ______		
- how long does it take the technician to come and pick up samples? ______		
Comments: ______		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
4. Are the sampler components carefully cleaned? Several points to be checked:		
- does operator clean the following before putting in new bag:		
Body of Sangamo with H_2O	___	___
Sensor grids with H_2O and ETOH	___	___
Outside of buckets with H_2O and ETOH	___	___
Hood gasket with H_2O and ETOH	___	___
- does he use new gloves and Kimwipes for above ______		
- what is the cleaning procedure under cold conditions? ______ ______		
Comments: ______ ______ ______ ______		
5. What problems does the operator experience with the sampler? How does he handle them? Some things that can happen:		
- does wet sample bag get stuck in container when being removed? ______ ______	___	___
- what does operator do if this happens? ______ ______ ______		
- what procedure is followed if the bag comes out damaged? ______ ______ ______		

Concord Scientific Corporation

Operator's Duties	Yes	No
- how often are leaks observed in bags? ________		
- what does he think causes it? ________		
Comments: ________		
6. In placing a new sample bag in the collector, does the operator observe the following points:		
- are new gloves worn when touching inside of bag?	___	___
- is operator careful not to touch inside of bag any more than is necessary?	___	___
- is bag forced to bottom of container by filling with air? ________	___	___
- is operator careful not to put hand inside bag when installing it?	___	___
- is enough bag left over the edge to permit knife edge to hold bag?	___	___
- are new gloves used to flatten bag against the pail?	___	___
- is collar cleaned, rinsed and dried before replacing on container?	___	___

Operator's Duties	Yes	No
- Does the end result produce a well fitting bag? (smooth surface, no overhang). ______		
Comments: ______		
7. Does the operator have a good knowledge of what he is expected to do? Specific points that the operator should be asked:		
- does operator have written instructions for procedures?	___	___
- which procedures does he have? ______		
- does he think he was adequately trained? ______	___	___
- when was the last time the regional technician reviewed procedures with him? ______		
- does he have any particular problems with the sampling? ______	___	___

Operator's Duties	Yes	No
Comments: ______________________		
______________________		
______________________		
______________________		
8. Does the operator have sufficient supplies on site? He should be asked:		
- does he receive regular shipment of supplies or as needed? ______________________		
______________________		
- does he have enough of the following:		
Sample forms	___	___
Bags	___	___
DI H_2O and ethanol	___	___
Kimwipes	___	___
Gloves	___	___
- has he ever run out of supplies	___	___
Comments: ______________________		
______________________		
______________________		
______________________		
9. What comments does the operator have about the programme?		
- does the operator understand why he is collecting the samples? ______________________	___	___
______________________		

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- does operator understand why all the special precautions (glove, cleaning bags etc.) are required? ______		
- does operator get any feedback on programme?	___	___
- Would he like feedback? How often? ______	___	___
- does he have any special comments with regards to the sampling, site, technician or programme as a whole? ______		
- Does he feel the pay is adequate?	___	___
Comments: ______		
10. Does the operator check sampler performance on a regular basis?	___	___
- does he check that hood seals tightly on wet and dry pails when reactivated?	___	___
- does he check that the sensor grid is warm?	___	___
- what other instrument checks does he perform periodically? ______		
- how often does he check the instrument? ______		

Operator's Duties	Yes	No
Comments: ____________________		
11. Does the operator maintain a site log book?	___	___
- What type of information is recorded ____________________		
- How often is information recorded? ____________________		
- Is a record kept of when events occurred? ____________________	___	___
Comments: ____________________		
12. Are sample submission sheets correctly and completely filled out? ____________________	___	___
13. Does the Regional Technician visit the site?	___	___
- how often? ____________________		
- does he talk to the operator on each visit, or is the sample just left at a location for pickup? ____________________	___	___

CUMULATIVE PRECIPITATION AUDIT - SANGAMO/MIC (continued)

Operator's Duties	Yes	No
- do the technician and operator discuss sample problems?	___	___
- other than talk to the operator what else does the technician do on his site visits? ________________________________		
Comments: ________________________________		

TYPE OF MONITORING - CUMULATIVE WET

INSTRUMENT - STORAGE GAUGE

Configuration Checks (Record results on "Storage Gauge Data Sheet")

1. Storage gauge opening should be level. Qualitatively test by placing level across opening. Note whether it is level, slightly out of level or not level.

2. Measure the height of the bottom of the storage gauge from the ground.

3. Measure the height of the orifice of the storage gauge from the ground.

4. Visually note any floating debris in guage or adhered to inside gauge walls. Using metre stick check for any sunken debris.

Calibration Checks (Record results on "Storage Gauge Data Sheet")

1. Gauge Opening - Measure inside opening of storage gauge with a ruler. Repeat at 90° from first reading.

2. Solution and Capping Layer - Visually note whether solution is methanol/ethylene glycol (slight alcohol - like odor) or water (no odor).

STORAGE GAUGE DATA SHEET

Site: ______________________________

Serial #: ______________ Model #: ______________

On Stand? ______________ Storage Gauge Height above ground ______________

Orifice Height above ground ______________

How is the base of storage gauge supported? ______________

____

Sample Orifice (cm) N-S ______________ level N-S ______________

E-W ______________ E-W ______________

Solution Type: Methanol Ethylene Glycol ______________

Water ______________

CUMULATIVE PRECIPITATION AUDIT - STORAGE GAUGE

OPERATOR: ____________________

SITE: ____________________

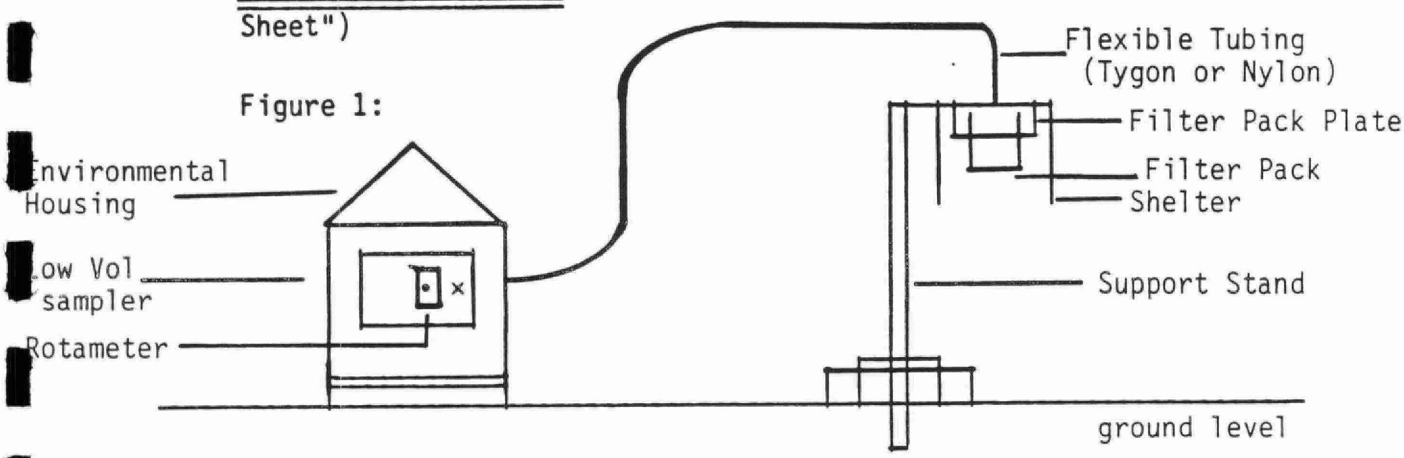
Operator's Duties	Yes	No
1. Does operator take a storage gauge measurement? ____ ____________________	___	___
2. Does operator check for debris in the gauge?	___	___
- on surface visually	___	___
- on the bottom using the meter stick	___	___
3. What does operator do if there is debris in the storage gauge? ____________________ ____________________		
4. How does the operator take the depth measurement? ____________________ ____________________		
5. Does the operator have a thermometer present for winter time measurements? ____________________ ____________________	___	___
6. Does the operator stir the solution and take temperature measurement 3-6" below surface? ________ ____________________	___	___
Comments: ____________________ ____________________ ____________________ ____________________		

TYPE OF MONITOIRNG - CUMULATIVE DRY

INSTRUMENT - METREX LOW-VOL SAMPLER

Configuration Checks (Record results on "Low-Vol Sampler Data Sheet")

Figure 1:



1. Note any deviations of the sampling configuration, (see Figure 1).

2. Observe flow rotameter. Is there a black ring on walls of rotameter? If yes describe ring thickness, colour (dark black, grey, brown).

3. The filter pack should be level. Qualitatively check by placing level across filter pack case. Note whether it is level, slightly out of level or not level.

Calibration Checks

1. Flow - Calibration of Rotameter: Turn off Lo-Vol Sampler and disconnect suction line from the back of the sampler. Place a 0-5 l/min mass flowmeter in line. Turn sampler and mass flowmeter on and allow 20 minutes for warm-up. Check for leaks in system. The output of the mass flow-meter should be connected to a digital voltmeter(scale 0-5 VDC). Use the flow control adjust on the sampler to perform a multi-point (10 values) calibration allowing 30 seconds per reading to allow the flow rate to stabilize (record results on "Rotameter Calibration Table"). The calibration should cover a range of 0-5 l/min.

METREX LOW-VOL SAMPLER DATA SHEET

Site: ______________________________

Serial #: ______________ Model #: ______________

On Stand? ______________ Height above ground ______________

Sample Orifice (cm) N-S ______________ level N-S ______________

E-W ______________ E-W ______________

Sampling line and tower in good condition? ______________

Kinks in suction line? ______________

Tower firmly supported, straight and steady? ______________

Low-Vol sampler - covered? ______________

____

- located so as not to be influenced by other nearby samplers or objects ______________

____

Rotameter Condition - grey, brown or black ring? ______________

2. Volume - Calibration of Volumetric Counter (Gas meter) The instrument set up for calibration is the same as in the "Calibration of Rotometer" except that once the flow controller has been set to approx. 2 l/min it should not be adjusted. When unit on volumetric counter changes start stop watch and record volumetric counter reading and mass flowmeter reading. Each time the volumetric counter changes (approximately 5 minutes) record volumetric counter reading, mass flowmeter reading in VDC, Low-Vol rotameter reading, and time (record results in "Volume Counter Calibration Table").

Rotameter Calibration Temperature ________

Reading #	Low-Vol Rotameter Reading 1/min	Voltmeter Reading (VDC)	Mass Flowmeter Reading (1/min)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Volume Counter Calibration Temperature ________

Reading #	Time (min & sec.)	Volume Reading (1 x 10)	Voltmeter Reading (VDC)	Mass Flowmeter Reading (1/min)	Low-Vol Rotometer Reading (1/min)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

CUMULATIVE DRY DEPOSITION - LOW VOL

OPERATOR: ______________________________

SITE: ______________________________

Operator's Duties	Yes	No
1. Describe the procedure used by the operator in handling filter packs. Does he do the following?		
- handle filter packs only by using a plastic bag or on the filter pack? ______________________________	___	___
- where are the filter packs stored? ______________________________		
Comments: ______________________________		
2. What information is recorded on data sheets?		
- flow rate - start and finish?	___	___
- volumetric reading?	___	___
- time of filter pack changeover?	___	___
- operator comments?	___	___
Comments: ______________________________		
3. What training did operator receive on the sampler		
- handling filter packs? ______________________________	___	___
- has he been retrained since?	___	___
- does he feel training was adequate		
Comments: ______________________________		

TYPE OF MONITORING - EVENT WET

INSTRUMENT - AEROCHEM METRIC

Configuration Checks (Record results on "Aerochem Metric Data Sheet")

1. The Aerochem Metric has a reputation for being blown over in winds. The sampler should be securily mounted by either stakes, wire or cross peices. Insure that the sampler can not be pushed over. (Figure 1).

2. The instrument should be level. Qualitatively check by placing clean plastic over the bucket with a level on top. Note whether it is level, slightly out of level or not level.

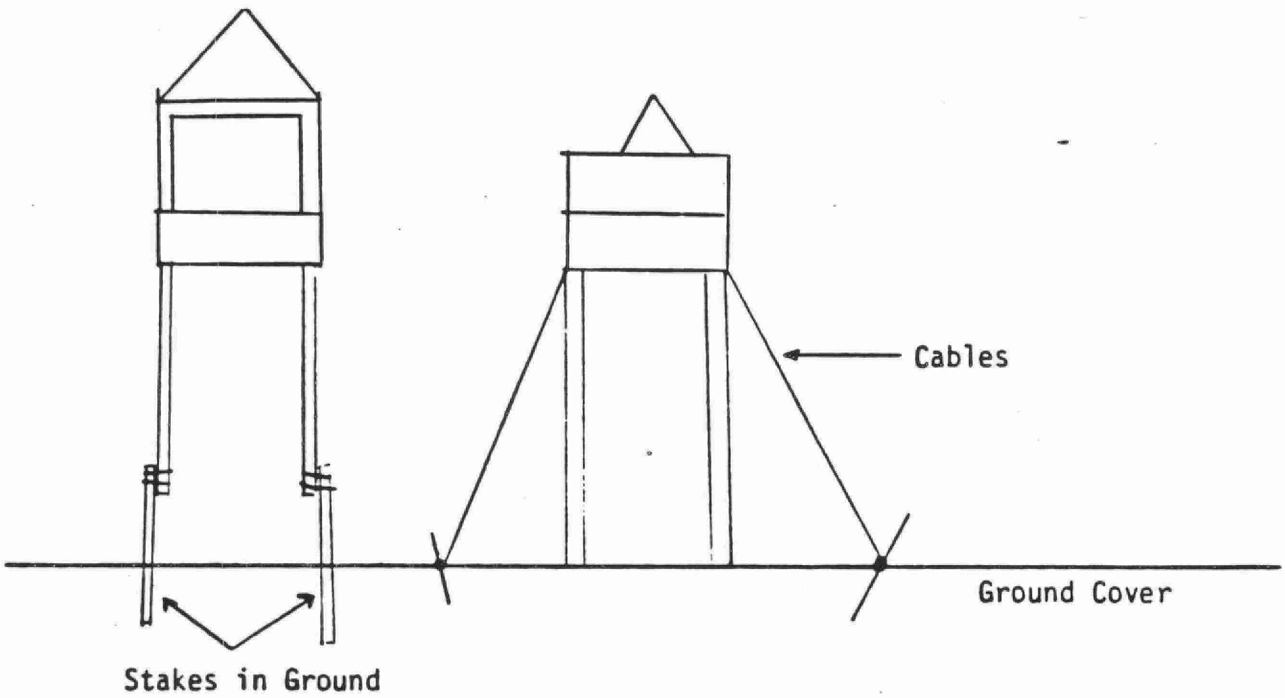
3. Check cleanliness of a) gasket, b) sensor, c) sensor body.

Calibration Checks (Record results on "Aerochem Metric Data Sheet")

1. Heating of Sensor - When sampler is not activated sensor should be cold to touch. When activated, the sensor should get hot after approximately 5 minute delay, and stay hot until activating precipitation evaporates.

2. Cover Seal Integrity - A thorough visual inspection of cover checking for: a) holes in polyethylene gasket cover;
   b) signs of gasket foam crumbling;
   c) moisture on inside surface of polyethylene.

FIGURE 1



AEROCHEM METRIC DATA SHEET

Site: ______________________________

Serial #: ______________ Model #: ______________

Sample Orifice (m) N-S ______________ level N-S ______________

E-W ______________ E-W ______________

Secured by: stakes ______________ sturdy? ______________

wire ______________

cross pieces ______________

	Yes	No
Cleanliness - Gasket	______	______
- Sensor	______	______
- Sensor Body	______	______
Any holes in gasket cover?	______	______
Is gasket foam crumbling?	______	______
Any moisture on inside surface of cover	______	______
Sensor heating properly?	______	______

Comments: ______________________________

____

____

____

EVENT PRECIPITAITON AUDIT - AEROCHEM METRIC

OPERATOR: ____________________

SITE: ____________________

Operator's Duties	Yes	No
1. What time does the operator check the sample bag for precipitation? If he cannot change at the proper time, what does he do? (phone technician, change bag when he can, contact alternate operator). ____________________		
2. Does the operator, while removing the sample bag from the sample bucket, allow for any chance of contamination of the precipitation sample? Several points that could lead to contamination are:		
- is the sample bucket removed from the sampler prior to changing sample bag?	___	___
- does the operator wear clean (new) plastic gloves to handle the bag?	___	___
- is the outside of the bag folded up allowing contamination to enter bucket?	___	___
- is the operator careful to not stand directly over sample bucket while removing sample bag? Is there potential for contamination from operator's hair, clothes etc.?	___	___
Comments: ____________________		

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
3. After the bag is removed from the sample container,		
- is air evacuated from the bag after being removed from container?	___	___
- is the top of the sample bag tied?	___	___
- how far from the top of bag is it tied?	___	___
- what is the sample bag tied with?	___	___
- any chance for othe contamination (clothing, etc)?	___	___
Comments: ______________________________		
4. For reloading the sample bucket:		
- in placing new bag in sample container, does operator wear gloves?	___	___
- does the operator touch the inside of bag when loading into sample container with only new, clean gloves?	___	___
- any chance for other contamination (clothing, etc.)?	___	___
Comments: ______________________________		
5. When the new bag is loaded in the sample bucket:		
- does the bag fit the container well? ___________	___	___
- how much of a decrease in orifice size results from poor bag fit? How much is the sample area reduced (%) ______________		
Comments: ______________________________		

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
6. Describe how the operator transfers the precipitation sample from the sample bag to the sample bottle?		
- does the operator inspect sample bottle for flaws?	___	___
- does he swirl bag and contents around prior to decanting?	___	___
- how is sample melted if partially or completely frozen? ______________________ ______________________		
- does operator pour sample directly from bag into sample bottle?	___	___
- does he use a clean funnel?	___	___
- does he elevate one bottom corner, clean, and cut it?	___	___
- describe cleaning procedure of bag and scissors? ______________________ ______________________ ______________________		
- if sample volume exceeds bottle contents, is excess poured into graduate and measured?	___	___
- where is the sample transfer area? ______________________		
- is a clean sample preperation area used?	___	___
Comments: ______________________ ______________________ ______________________		

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
7. Sample bottles should be labelled to correspond with date submission sheets:		
- what information is placed on sample label? ______ ______		
- is label placed on cap or bottle? ______ ______		
- where are samples stored for pickup by technician? ______ ______		
- how long are samples usually stored prior to pick-up by technician? ______ ______		
Comments: ______ ______ ______		
8. What information is entered on the data sheets?		
- is any information not filled out or incorrectly filled out? ______ ______ ______	___	___
9. Is there a log book on site?	___	___
- what information is recorded? ______ ______		
- how often is information entered into log book? ______ ______		

EVENT PRECIPITATION AUDIT - AEROCHEM METRIC (continued)

Operator's Duties	Yes	No
10. When was the last time technician reviewed sampling procedures with operator? ________		
- how often are procedures reviewed? ________ ________		
- does the operator think procedures should be reviewed more often? ________	___	___
- does he think he was adequately trained	___	___
- does he have any particular problems with the sampling	___	___
Comments: ________ ________		
11. Does the operator have sufficient supplies to last for one week, one month, six months? Has the operator ever run out of supplies? ________	___	___
________ ________		
12. What comments does the operator have about the programme?		
- does the operator undertand why he is collecting the sample? ________ ________	___	___
- does he understand why all the special precautions (gloves, cleaning, etc.) are required	___	___
- does operator get any feedback on programme? Would he like some? How often? ________ ________	___	___
- does he feel the pay is adequate?	___	___

TYPE OF MONITORING - EVENT WET

INSTRUMENT - STANDARD RAIN GAUGE

CONFIGURATION CHECKS
(Record results on "Standard Rain Gauge" Data Sheet)

1. Measure from collector rim to ground.

2. Measure from top of grass to collector rim.

3. Inspect funnel and graduate for cracks and cleanliness.

4. Determine height of and distance to nearest obstruction, including sampler.

5. Insure that gauge is emptied each morning.

6. The instrument should be level. Qualitative check by placing level over gauge orifice. Note whether it is level, slightly out of level or not level.

7. Pour pre-measured 50 ml aliquot into gauge and record reading.

STANDARD RAIN GAUGE DATA SHEET

Site: ______________________________

Serial # ______________ Model # ______________

Collector rim to ground ______________

Collector rim to grass ______________

		Cracked	Clean
Graduate	(Yes, No)		
Funnel	(Yes, No)		

Obstruction	Height of Obstruction (m)	Distance from Gauge (m)

Gauge Level ______________________________

Gauge Reading ______________________________ (mm)

EVENT PRECIPITATION - STANDARD RAIN GAUGE

OPERATOR: ______________________________

SITE: ______________________________

Operator's Duties	Yes	No
1. Is the standard gauge checked each day?	___	___
2. How does the operator handle the following situation:		
- if water level (meniscus) falls between two graduated marks? ______________________________		
- what is recorded if level is below 0.2 on scale? ______________________________		
- if there is water that has overflowed the graduated cylinder, what does the operator do? ______________________________		
- what is done for freezing rain? ______________________________		
- is the graduated cylinder is dirty? ______________________________	___	___

TYPE OF MONITORING - EVENT WET

INSTRUMENT - NIPHER SHEILDED SNOW GAUGE

Configuration Checks (Record Results on "Nipher Sheilded Snow Gauge Data Sheet")

1. Is the gauge mounted on a stand?

2. Is the mounting stand safe and secure?

3. Measure the distance and the direction from the primary aerochem metric sampler.

4. Instrument should be level. Qualitatively check by placing level across bucket orifice. Note whether it is level, slightly out of level or not level.

5. Measure the height of bucket orifice above ground.

Calibration Checks (Record Results on "Nipher Sheilded Snow Gauge Data Sheet")

1. Measure shield orifice and bucket orifice diameter.

2. Pour a 200 ml aliquot into the gauge calibrated depth graduate and record result.

NIPHER SHEILDED SNOW GAUGE DATA SHEET

Site: ____________________

Serial #: ____________________

Model #: ____________________

On Stand? (Yes/No) ____________________

Is the stand safe and secure? ____________________

____

Distance and direction from sampler. ____________________

____

Pour 200 ml into calibrated depth graduate. Result_______cm.

Height of orifice above ground ____________________

Shield Orifice (cm) N-S __________ Bucket (cm) N-S __________

E-W __________ E-W __________

Level N-S __________

E-W __________

EVENT PRECIPITATION - NIPHER GAUGE

OPERATOR: ____________________

SITE: ____________________

Operator's Duties	Yes	No
1. Does the operator have the following supplied:		
- 2 collection vessels?	___	___
- calibrated volumetric .	___	___
- funnel?	___	___
Comments: ____________________		
2. During the time of year when the Nipher gauge is used what does the operator do if it rains? ____________________		
3. Describe procedure followed if sample volume exceeds graduated cylinder volume? ____________________		
4. What does the operator do in the case of freezing rain? ____________________		

APPENDIX II

SITE AUDIT SUMMARIES

FALL 1983

SITES VISITED DURING PHASE I AUDIT

(Sites are shown in the order audited)

	SITE	TYPE
1.	Longwoods	Event
2.	Alvinston	Cumulative
3.	Melbourne	Event
4.	Mattawa	Cumulative
5.	Azure Lake	Cumulative
6.	Moonbeam	Cumulative
7.	Nithgrove	Event
8.	Campbellford	Cumulative
9.	Graham Lake	Event
10.	Golden Lake	Cumulative
11.	Colchester	Cumulative
12.	Shallow Lake	Cumulative
13.	McKellar	Cumulative

Longwoods Conservation Area

November 29, 1983 Temperature: 2.0° C

Site Evaluation

Advantages
- overall good site
- good ground cover
- co-located site AES Capmon Network
- site representative of local area i.e. agricultural and conservation area
- typical topography - gentle rolling hills

Disadvantages
- on-site obstructions - 3 deciduous trees ~ 8 - 10 m tall, 7 m east of compound - Fisher-Porter gauge ~ 2 m tall, 3 m south of primary sampler
- trenches dug for burying cable have not been seeded or sodded; therefore, some exposed earth
- shed used for sample changing is rather crowded with instruments and supplies. May have an effect on the quality of the sample changing as operator tends to bump and spill samples
- poor windbreak to the east
- wood burning 40 m west in garage

Instrument Evaluation

Aerochem
- co-located Aerochems
- heavy flurries on the day of the audit. Primary sampler was opened while secondary sampler was closed

- a few drops of precipitation noticed on the gasket of both samplers
- regional technician cut a few holes in the bottom of the Aerochem buckets allowing the air normally trapped behind the bag to escape. This results in a better bag fit

Nipher

- a guy wire holding the Nipher shielded snow gauge in place was broken; as a result the stand was not very secure. The shield could quite possibly be blown over by a strong wind
- the bucket was level and shield in good condition
- recommendation: fix broken guy wire

Operator Evaluation

Operator: Dave Little

- operator tries to check the sampler for precipitation each day at 08:00 hours or as soon as possible
- the operator finds the sample changing area too cramped with equipment and supplies
- the operator wears only 1 pair of poly gloves during the bag removal/insertion procedure
- contamination is a definite problem, operator's coat touches the bag several times. Operator suggested that in order to avoid this when smoothing the bag against the side of the bucket that he wear gloves to his elbows or use a bag insertion procedure similar to the one used by the Capmon Network

- when transferring the sample, the operator transfers the sample from the bag directly into the event bottle, he elevated a bottom corner of the bag and cuts it with a pair of rusty scissors. He does not clean the bag or scissors
- operator was given the new APIOS Technical and Operating Manual but has not read it - does not think he will have a chance to read it in the near future
- operator believes he has a good knowledge and understanding of the program; however, he would like to see APIOS give a seminar/workshop to all the operators in the region. At this seminar/workshop he would like to discuss sampling protocol, how the APIOS Network operates and its importance, a brainstorming session with other operators about their sites and difficulties they may encounter
- operator would appreciate it if the APIOS and Capmon Networks standardize their method of recording sampling dates. He finds this confusing and may result on entering data improperly
- operator has a good working relationship with the regional technician - this is vital at Longwoods as a poor relationship with AES people has already resulted in a poor attitude towards the Capmon Network

Corrective Action Required

- remove all on-site obstructions - trees within 2.5 heights of sampler - relocate Fisher-Porter gauge
- sod exposed earth where trenches have been dug
- enlarge shed used for sample changing
- regional technician should review sampling protocol with operator and show him what sections of the APIOS Technical and Operating Manual pertain to his site
- operator should be given a new pair of scissors

ALVINSTON

December 29, 1983 Temperature: 2° C

Site Evaluation

Advantages
- representative of local topography (rolling hills)
- removed from vehicular and major point sources
- good windbreak and ground cover
- representative of local area which is predominatly agricultural
- trees surrounding the site should help to minimize the influence of windblown dust - however all trees within 2.5 x heights should be removed
- gravel/dirt road east of site is separated by a bank of trees

Disadvantages
- some trees and shrubs surrounding the site are obstructions as they are within 2.5 height of sampler - especially a pine tree 6 m tall 7 m east of site
- slight slope at site from east to west (downward slope)

Instrument Evaluation

Sangamo
- breaker tripped a week prior to audit and as a result approximately four inches of precipitation had been collected in the dry bucket which is not supposed to be used anymore. A new recepticle GFIC breaker had been installed November 9, 1983 by regional technician.

The instrument should be checked regularly by activating the sampler to ensure that it is functioning properly.

- the resistance necessary to activate the sampler was somewhat low 40 Ω compared to the specified 220 kΩ
- instrument seem to be in good working order otherwise

Storage Gauge

- storage gauge on "adjustable" stand design by Tech. stand is non-standardized
- stand was staked solidly into ground
- sampler was level
- U-bolt for standardized gauge measurement had not been installed

Operator Evaluation

Operator: Paul DeVlught

- operator wears only one pair of gloves during entire bag removal/installation procedure
- bag exposed to the elements under knife edge is turned inward, possibly contaminating the sample
- operator cleans the knife edge collar and bucket with DI H_2O at each changeover date
- conscientious operator, interested in APIOS programme
- he is a little discouraged by the fact that the sample changing must be carried out on a particular day at a

particular time but samples are not picked up and sent in for analysis within 36-48 hours. He is concerned about sample integrity.

- operator visually checks the instrument once a week but should be encouraged to perform other check as well, i.e., ensure sensor is warm and reacting properly
- operator would like to meet other operators and MOE employees associated with APIOS Network
- encourages Network to hold a seminar/workshop on sampling protocol, new developments in the Acid Rain programme, etc.
- communication between operator and Tech. is maintained via phone calls and short memos. He does not necessarily see the regional technician every time samples are picked up.
- operator should be shown sample changing protocol. He has read APIOS Technical and Operating Manual but still is not following proper sample changing procedures
- operator has a good attitude towards the programme - seems very interested in Acid Raid and frequently requests literature on the subject from regional technician.

Corrective Action Required

- remove all trees which act as obstructions within 2.5 heights of sampler
- retrain operator

Melbourne

November 29, 1983 Temperature: < 0° C

Site Evaluation

Advantages
- isolated from major point sources
- representative of rural/agricultural area/flood plain
- good ground cover and level

Disadvantages
- on top of a small hill near flood plain
- home on site heated solely by wood burning - chimney located ~ 13 m south of site
- on site obstructions include small pine trees and a hydro pole 10 m tall ~ 20 m east (pole believed to have minimal influence) 2 deciduous trees H - 15-20 m, H - 25 m
- cement plant located 4 km west
- site located in an area almost totally dedicated to mixed farming - poor windbreak surrounding the site iteself; therefore, nothing to minimize the influence of wind blown dust and snow

Instrumentation Evaluation

Aerochem
- operator discouraged by sensitivity of aerochem - often events occur but no sample is collected by instrument
- sensor should be cleaned on a regular basis - quite dirty when audit was carried out

Nipher - on stand held down by rope - suggested that the rope be replaced by cable tighteners and stronger cable
- the bucket and shield were both in good condition

Operator Evaluation

Operator: Michael Haas

- operator should be retrained - he was following old sampling procedures even though he had been given updated procedure sheets by technician.
- operator has APIOS Technical and Operating Manual but has not read it. Did not believe that he would read it in the near future
- operator seldom sees technician - only during summer months when he is at home
- communication is maintained mainly by notes left when technician picks up samples
- unsure of when he is supposed to use the Nipher and Rain gauge - he was waiting for instructions from technician. Several events had occured where the only type of precipitation collected was snow - operator was still using standard rain gauge
- conscientious operator, interested in APIOS program
- became discouraged when an event occurs and no precipitation is collected - prefers SES bucket over Aerochem

- does not follow protocol; therefore, contaminated sample and poor bag fit - unsure of why all special precautions are taken
- would like more information about Acid Rain and APIOS Network and specific feedback (quarterly)
- if operator were retrained with proper procedures and sampling technique he would then become a "good" operator. He still holds great enthusiasm for the program.

Corrective Action Required

- obstructions should be removed i.e. cut trees which are within 2.5 heights of sampler
- operator must be upgraded on procedures set out in the APIOS Technical and Operating Manual

Mattawa

December 4, 1983 Temperature: -1° C

Site Evaluation

Advantages - good ground cover (cut grass)

- good windbreak except to the north and northeast
- representative of local topography and vegetative ground cover

Disadvantages - proximity to Calvin-Papineau township road (40 m west)

- proximity to saw mill 4 km east of site - burns wood continuously
- proximity to lumber mill 20 km west of site - also burns wood continuously
- on-site obstructions include tall brush, trees and weeds southeast of site ~ 8-12 m tall and 15-20 m away (on a small hill)

This audit was a revisit. Site has improved somewhat since first audit in spring 1982. Exposed earth has been sodded, area immediately surrounding the primary sampler has been leveled.

Operator - operator used to burn all of his garbage ~ 4 m west of sampler. He now brings garbage to the dump and occasionally burns cardboard boxes, usually at night when there is no wind. He covers low vol filter pack with a shower cap and wet bucket with a clean bag. He never burns boxes when it is raining or snowing.

Instrument Evaluation

Sangamo
- sensor grids very hot and blackened. Regional technician was to change them during next visit
- chain skipped causing hood to jerk
- loud ringing noise made during hood movement
- poor bag fit
- resistance required to activate sample > 3000 k Ω

Storage Gauge
- not level - should be leveled during regional technician's next visit to site
- 10W30 used as capping layer rather than transmission oil - modified gauge with u-bolt

Low Vol
- good operating condition
- tygon tubing frozen solid from instrument to filter pack

Operator Evaluation

Operator: John Brayshaw

- operator was in the process of reading the new APIOS Technical and Operating Manual and changing sampling protocol
- uses only one pair of poly gloves during bag changing procedure
- folds top of bag inward exposing contaminated surface to sample
- during winter period operator cleans knife edge and gasket with both DIH_2O and ETOH

- conscientious operator - interested in APIOS program
- would like more feedback every 3 - 4 months
- should be shown sample changing protocol by regional technician
- good relations with regional technician

Corrective Action Required

- remove all obstructions i.e. trees within 2.5 heights to sampler
- some maintenance work required on Sangamo
- storage gauge should be leveled
- upgrade operator on new procedure

Azure Lake

December 6, 1983 Temperature: -2° C

Site Evaluation

Advantages
- good ground cover and windbreak (tall coniferous trees)
- site is level
- well removed from industrial and urban activities
- operator conscientious
- representative of local area (mixed forest) and vegetative ground cover
- very light vehicular influences from roadways

Disadvantages
- Access roads off Hwy 144 are in poor road conditions during winter and spring prevent site from being easily accessed
- no telephone on site; therefore, when instruments are down or problems arise information cannot be relayed immediately to regional technician
- on site obstruction - one pine tree 2-3 m tall less than 3 m from sampler - should be removed
- building within 3 heights - snow blown off roof is a potential problem

Instrument Evaluation

Sangamo
- good gasket seal on knife edge
- chain (motor) skips causing hood to jerk when moving. Hood is not secured properly to instrument and can rock freely in a strong wind

- sensor grids were blackened
- pins to hold hood to arm not fitted properly
- bucket not level
- very little resistance needed to activate sampler i.e. 10 Ω rather than 220 k Ω

Storage gauge - on stand orifice height above ground = 139 cm
- level and in good condition

Operator Evaluation

Operator: Donna Gareau

- good operator, conscientious and very interested in APIOS Network
- just received manual but has not read it completely. Regional technician listed sections of manual pertaining to the activities at this site and advised operator to read them
- operator used DIH_2O as well as ETOH to clean knife edge and gasket. Frozen water droplets noticed on both gasket and collar after cleaning
- operator is careful not to contaminate sample
- bag fit not superior - bag bunched up at top of bucket, not smooth against side of bucket
- used a dirty glove to flatten bag
- operator would like a retraining session with regional technician on procedures in new APIOS Technical and Operating Manual

- would like to see a one day seminar/workshop given where all operators from the region get together to discuss Network's objectives, sampling, protocol, instrumentation and trouble shooting
- operator used to record many comments in her log book pertaining to instruments and local activities which might affect sample integrity; however, no one ever read them or sent them off with submission sheets so she no longer does this

Corrective Action Required

- remove all on-site obstructions i.e. trees within 2.5 heights of sampler
- instrument requires servicing
- operator requested retraining

Moonbeam

December 7, 1983

Temperature: -27° C
-35° C (with wind chill factor)

Site Evaluation

Advantages - no on-site obstructions

Disadvantages

- poor windbreak
- poor ground cover - mostly clay - access difficult in spring because of mud
- not representative of local area. General area is mostly forested however, site is located in an open meadow surrounded to the north by abandoned fields
- proximity to concession road may contribute to dust and dirt in samples. Site should be carefully reconsidered as an APIOS site as many of the siting requirements are not met
- proximity to paper mill 20 km west of site, continuous burning of wood chips
- proximity to the town of Moonbeam

Instrument Evaluation

Sangamo

- old model of knife edge with gap at this site
- clutch does not skip at 14 lbs.
- very little resistance $< 40\ \Omega$ required to activate the sampler

- rusted u-bolt at base of instrument should have been replaced by galvanized u-bolt

Metrex Low Vol - tower not firmly supported - rocks easily

- tygone tubing frozen to back of instrument

Storage Gauge - not level, otherwise in good condition

- storage gauge has not been modified i.e. no u-bolt installed for storage gauge reading

Operator Evaluation

Operator: Rolly Filion

- new operator
- poor operator, does not follow protocol even though he has been shown sampling procedures on several occasions
- contaminated surfaces of the sample bag are exposed to the sample when tieing the bag, potential for contamination by operator's clothing and hands exists throughout entire changing procedures
- operator has never cleaned any of the instrument components i.e. gasket, knife edge, sensor grids, etc.
- operator visits site only once every 28 days to change bag and filter - he does not perform any instrument checks
- operator slips bag into bucket without filling the bag with air then pulls edge of bag over the rim of bucket
- bag orifice is reduced by 80 %

- operator was not aware that a long bucket was to be used for winter sampling - he thought someone had stolen the short bucket
- operator does not understand the basic functions of the instrument and various components i.e. sensor grids
- operator wanted to leave the hood midway between the two buckets with the instrument turned off in order to allow the snow to accumulate in bucket during the winter. He was not aware that the snow landing on sensor grids would activate the sampler
- instrument was not working - under direction of regional technician operator changed the fuse and checked breakers, when this failed to fix instrument the regional technician made a special trip to site only to find that the operator had not plugged in sampler
- operator should be retrained in french, he seemed interested in program and willing to help out in any which way he can. However, if this fails a new operator should be found

Corrective Action Required

- try to relocate site (may consider co-locating with nearby Capmon site at Bonner Lake, approximately 7 km northeast)
- operator should be replaced

NITHGROVE

December 8, 1983 Temperature: - 5° C

Site Evaluation

Advantages
- good site, well removed from industrial, agricultural and urban activities
- representative of local topography (hilly) and vegetative ground cover
- representative of local area which is characterized by forests and lakes
- good windbreak in all directions except to the north facing the lake
- good ground cover and level

Disadvantages
- on-site obstruction are birch trees 8 - 10 m tall 15 m west of sampler and pine tree 4 m tall 8 m northeast - plans have already been made to have clearing enlarged and obstructions removed in spring 1984
- horses, cows and goats graze in meadow on site. A fence will be constructed around the samplers in the spring 1984 preventing animals from damaging instruments.
- proximity to plywood mill
- proximity to wood heating home

Instrumentation

Aerochem - instrument was off level and should be leveled

- snow was observed in the dry bucket. On numerous occasions operator has noticed an event has occured but no sample collected in the wet bucket
- the instrument was clean, sturdy and gasket in good condition

Nipher
- located 4 m east of primary sampler
- Nipher was off level and should be leveled
- the stand was not very secure and tends to rock easily

Operator Evaluation

Operator: Paul Kack

- excellent operator - follows sampling procedures exactly as they are set out in the APIOS Technical and Operating Manual
- operator has read the manual a few times and discussed it with regional technician
- very consciencous operator with keen interest in the program and APIOS Network

Corrective Action Required

- cut down trees which are obstructions within 2.5 heights of the sampler
- install fence around instruments

Campbellford

December 12, 1983 Temperature: -2° C

Site Evaluation

Advantages
- well removed from industrial and large urban influence
- good ground cover, level area
- site is representative of local area - mixed forest and dairy farms

Disadvantages
- poor windbreak to the north
- very open area
- poor access in winter - road inside of park is not plowed - arrangements should be made to have this done
- proximity to Campbellford ~ 2 km north, population 4,000
- proximity to Stirling Road ~ 500 m east of site - separated by a large hill
- tall weeds/hay-like grass surrounds the site - should be cut and maintained
- compound becoming crowed by the addition of a second low volume

Instrument Evaluation

- unable to carry out audit on the instruments
- instruments were down and covered with approximately 2.5 cm of ice (see photograph)
- Sangamo hood was frozen in the open position
- reset breaker at receptable and power was not restored
- power out in surrounding area during audit

Operator Evaluation

Operator: Ken Grant

- good operator, follows procedures exactly as described in manual, only deviation is that he only wears one glove on right hand when changing bag
- operator only received sections of the APIOS Technical and Operating Manual pertaining to the instruments on site
- new operator - has never done any winter sampling, Tech should go through changes in procedures i.e. cleaning gasket, knife edge, etc. with ETOH only, long bag installation, recording temperature of storage gauge
- operator brings instructions to the site at changeover and follows them
- very interested in program and would like to receive additional information on Acid Rain, and the APIOS Network - regional technician should forward the APIOS Technical and Operating Manual (complete manual) to him
- operator believes seminars and workshops would prove quite valuable
- very conscientious and interested
- operator should be encouraged to visit site more than once or twice a sampling period and perform instrument checks

Corrective Action Required

- access road to site should be plowed during winter months
- cut and maintain tall weeds
- have regional technician give the complete APIOS Technical and Operating Manual to the operator

Graham Lake

December 13, 1983 Temperature: 3° C

Site Evaluation

Advantages - site is representative of local area, topography and vegetative ground cover
- well removed from industrial, agricultural and urban influences
- no on-site obstructions

Disadvantages - poor windbreak to the south
- large hill to the southeast of site
- proximity to concession road which may contribute to excess of wind blown dust (seasonal use only)
- ground slopes downward from the south to the north surrounding the site

Instrument Evaluation

Aerochem - ice and snow was observed in dry pail. Gasket was in poor condition, sensor grids were not responding properly when sampler was activated by fallen snow. Very long delay time
- instrument was off level and should be leveled
- hole in gasket - missing cover for GFIC receptable

Nipher - Nipher on stand, secure
- off level and should be leveled

<u>Operator Evaluation</u>

Operator: Don Blair

- operator was not available to meet with auditor he day of the audit - unable to leave his place of business
- operator has never met with regional technician since the initial training period. Communication is maintained through occasional short notes and phone calls

<u>Corrective Action Required</u>

- relevel Aerochem and Nipher
- replace Aerochem gasket
- new cover for GFIC receptacle

Golden Lake

December 14, 1983 Temperature: -0.5° C

Site Evaluation

Advantages

- good site well removed from industrial, agricultural and urban activities - site is representative of local topography and vegetative ground cover. Level area
- good ground cover and windbreak
- no vehicular activity on site

Disadvantages

- on site obstructions include deciduous and coniferous trees with 2.5 heights. Plans have already been made to have these removed during the spring of 1984
- access to the site is poor during winter months because of deep snow
- cannot drive up to site except with 4-wheel drive

Instrument Evaluation

MIC (primary)

- instrument is off level and should be leveled
- resistance necessary to activate the sampler is < 10 Ω compared to the specified 220 k Ω
- clutch does not slip at the recommended 14 lbs., does not even slip at 30 lbs.
- sensors were in good condition, warm to touch with a pulsing current
- hood movement is smooth, limit switch adjustment good and gasket seals tightly on knife edge

MIC (secondary)

- instrument is off level and should be leveled
- resistance necessary to activate the sampler is < 10 Ω compared to the recommended 220 k Ω
- clutch slips at > 30 lbs. and not at the suggested 14 lbs.
- sensors are in good condition, warm to touch with a pulsing current
- hood movement smooth and limit switch adjustment good
- poor gasket seal, ice has frozen on knife edge resulting in an improper seal

Metrex Low Vol

- sampler inside housing on a sturdy stand
- sampling tower sturdy and in good condition, sampling line in good condition
- tygone tubing had frozen to back of instrument
- volume counter calibration off by -2 % and time counter off by -2.5 %

Storage Gauge (co-located)

- sitting on top of ground securely and not on a stand (during winter months gauge height above snow pack may not be sufficient)
- gauge is level and has been modified by the addition of a u-bolt to be used for standardizing depth measurement

- one storage gauge has been leaking over past few months. Depth measurements were decreasing as time passed

Operator Evaluation

Operator: Andrew Polley

- excellent operator - experience in various types of field sampling - able to carry out maintenance and servicing of instruments when problems arise
- very interested in APIOS Network
- operator does not wear poly gloves to remove or install bags - he is extremely careful not to contaminate sample or bag - he does wear a clean glove to pat bag against sides of bucket
- believes MOE should have an annual dinner for APIOS operators - with speakers on the program network's objectives and new developments in Acid Rain

Corrective Action Required

- remove all on-site obstructions i.e. coniferous and deciduous trees within 2.5 heights of samplers
- primary MIC should be leveled
- storage gauge should be on a stand during winter months

Colchester

December 16, 1983 — Temperature: -2° C

Site Evaluation

Advantages
- good ground cover
- entire area well maintained
- topography representative of local urban area
- ground is flat and level

Disadvantages
- no windbreak between roads and houses 125 m north and 25 m east of site
- hydro wires overhang too close to site (13 m)
- playground being constructed adjacent to site increasing the amount of human activity in the area
- site is located in an urban area at water treatment plant
- chlorine tanks ~ 40 m southeast changed every 2 weeks, possibility of leaks during changeover
- diesel generator is operated for 2 hours every week
- site located in town of Colchester
- barbed wire fence exceeds height of sampling orifice
- area is very open
- proximity to Lake Erie

Instrument Evaluation

MIC
- sensor not heating at time of audit. The sensor was not warm to the touch and only 1 volt d.c. non-pulsing was measured using a digital multimeter. Heating of

the sensor should be checked weekly by the operator simply by checking if the sensor is warm to the touch

- "c" clamps are used to limit movement of the hood on dry bucket side. Since the clamp is only on one side of the sampler, with time twisting of the arms that support the hood might be expected. One method to limit movement of the hood should be chosen and adapted to all instruments (Alvinston still has dry bucket in place)
- the instrument was activated at 10 ohms compared to the specified 220 k ohms
- one limit switch slightly off center
- instrument in good working order otherwise. Smooth hood movement and good seal in knife edge

Low Volume

- sampler could not be adjusted to sample greater than 1.4 l/minute at time of audit. Problem has occurred before (2 years ago) and that instrument was replaced
- filter pack stand located too close to the fence, possible source of contamination. Stand should be moved to another location in the compound
- rotameter reading off by 12 % of actual flow rate
- volume counter calibration accurate
- instrument is located in a good shelter and is well supported

Storage Gauge - storage gauge located on a solid stand which was in the ground

- sampler level
- on an adjustable stand, non-standardized

Operator Evaluation

Operator: Don Marontate

- good operator - uses outlined procedures when changing bags and operating site
- instrument components should be cleaned more often. MIC sensor needed to be cleaned at time of audit
- site is located at Ministry of the Environment Water Treatment Facility of which Don Marontate is employed. No problems with changing the sample on time and the sampler is checked frequently during the sampling period
- operator has no problems with sampling procedures and understands why precautions are necessary when handling samples

Corrective Action Required

- consider relocating site further from urban activity and Lake Erie
- servicing required on MIC

Shallow Lake

December 13, 1983 Temperature: -10° C

Site Evaluation

Advantages
- well removed from industrial and vehicular sources
- good ground cover, level
- representative of local topography (rolling hills)
- representative of local area which is mainly a mixed forested area and some agricultural activity

Disadvantages
- no windbreak in prevailing wind direction
- proximity to hay field ~ 10 m - source of windblown particulates and dust
- proximity to home which is heated by oil and wood burning
- deep snow in winter months makes accessibility difficult

Instrument Evaluation

MIC
- instrument supported well and on a good stand
- no problems detected with instrument operation. Sensors heating and mechanical operation good
- sampler activated with 10 ohms resistance compared to the specified 220 k ohms
- overall, the sampler was in good working order and has been well maintained

Low Vol
- instrument located in a good shelter and on a solid support

- tower in good condition and no kinks in suction line
- rotameter calibration off by 5 %
- volume counter calibration off by 2 %
- overall, instrument is in good working order

Storage Gauge
- storage gauge on stand with adjustable height
- supported well and level
- capping layer transmission fluid

Nipher (special study)
- Nipher gauge well supported and level
- this Nipher gauge is a special study in that measurements are taken in the same manner as the storage gauge so that the collection efficiency can be measured and compared to the storage gauge

Operator Evaluation

Operator: Larry Struther
- operator has reviewed the APIOS Technical and Operating Manual and has changed his bag changing technique as outlined
- no problems noted in bag changing procedure
- operator feels the bags are often too hard to install in the bucket and worries about contaminating the inside of the bag
- the instrument body and component parts should be cleaned more often

- operator is very conscientious when changing sample bags and follows all instructions carefully. Operator feels he could use more training in filter pack handling techniques and thinks periodic retraining is necessary
- because the operator teaches during the day he rarely sees the regional technician during the winter months. It is important that the operator and regional technician consult on a regular basis to identify sample and instrument problems

Corrective Action Required

- consider relocating to improve accessibility during winter months, minimize effects of hay field and home heating sources

McKellar

December 21, 1983 Temperature: -8° C

Site Evaluation

Advantages
- good ground cover
- well removed from industrial influences

Disadvantages
- poor windbreak to the east and south
- proximity to Highway 124
- on-site obstruction - 4 m pole at ~ 5 m southeast of instruments
- site is adjacent to a farm; however, the area is typically forested; therefore, not representative of local area and vegetative ground cover
- site should be relocated to a forested area away from agricultural activities

Instrument Evaluation (co-located)

Sangamo (primary)

- improper gasket seal, hood sits approximately 5 cm above knife edge
- one sensor did not activate sampler when wetted
- both sensors were blackened
- limit switch was slightly off center
- operator indicated during a telephone conversation a week prior to the audit that the instrument had blown several fuses. This is a serious problem as substantial amounts of precipitation had not been collected during this down-time

- instrument was activated by a resistance of 4 Ω compared to the recommended 220 k Ω
- the number of problems outlined above would suggest that a complete overhaul is necessary

Sangamo (secondary)

- instrument off level and should be leveled
- both sensors were blackened and only 1 volt (non-pulsing) was measured on the heater by a digital voltmeter
- the instrument was activated by a resistance of 4 Ω compared to the recommended 220 k Ω
- this instrument had also blown several fuses a week prior to the audit
- hood movement was not smooth
- this instrument should also be overhauled

Low Vol (primary)

- instrument located in a good shelter on a solid support
- tower is in good condition and no kinks in suction lines
- volume counter calibration accurate

Low Vol (secondary)

- instrument located in a good shelter on a solid suport
- tower in good condition and no kinks in suction line
- volume counter calibration accurate

Storage Gauge (primary)

- sample orifice out of round
- gauge well supported and level
- 10W30 used as capping layer rather than transmission fluid
- u-bolt had been installed for measurement

Storage Gauge (secondary)

- gauge well supported and level
- 10W30 used as capping layer rather than transmission fluid
- u-bolt had been installed for measurement

Operator Evaluation

Operator: Jim Roberts

- operator did not show up for audit
- operator had not changed sample on changeover date
- when technician from regional office was sent to pick up samples - both Sangamos were down and fuses had been blown
- samples had not been changed and were still sitting in buckets
- technician did not have spare fuses with him; therefore, he was unable to change samples and repair instruments

Corrective Action Required

- remove pole height 4 m ~ 5 m southeast of sampler (if it is of no use)
- service instruments. Complete overhaul of primary and secondary Sangamos.

APPENDIX III

TECHNOLOGISTS' QUESTIONNAIRE

APPENDIX III

Questions Asked During Technologists' Audits

1. Frequency of site visits, instrument calibration, routine instrument checks, preventive maintenance, data screening and validation, and other routine QA/QC procedures.

2. Type of log books kept
   - on site
   - at regional office
   - by Technician.

3. What do the Technologists think of the manual, the QA Plan?

4. What procedure was used for distributing manuals to operators and was there any subsequent follow-up with operators?

5. Any problems with GFICS, receptacles or breakers?

6. Discuss how well instruments are running in general.

7. What procedure did Technologist use to prepare site summary and ranking?

8. What preventive maintenance is carried out, both included and not included in technical procedures? (See Table 1.)

9. What training do Technologists receive in Toronto and when was the last time Technologists were retrained?

10. What updated training have Technologists given operators?

11. How is blank of event bottle (and weight) determined?

12. Have the stands for niphers been modified from the original design? If so, how, and why?

13. Are lids used for nipher buckets at all during melting of snow?

14. How is pH/field taken?

15. Describe procedure for handling filter blanks.

16. How are site and instrumentation log books prepared and the recorded information used?

17. What spare parts do the Technologists have at regional office and at sites, for:
    - Aerochem
    - Sangamo
    - Standard Rain Gauge
    - Other.

18. How are sample weighing scales calibrated?

19. How is storage gauge winter solution prepared?

20. Do Technologists carry out audits of operators?

21. How are composite samples handled by operators for cumulative network?

22. Describe operator Low-Vol unloading procedure.

23. General comments re communication with 880 Bay Street and region (good/bad).

24. Check office-lab setup and van.

25. Discuss the validity and comments of site evaluations carried out during Fall 1983 site audits.

CUMULATIVE WET - TECHNICIAN'S QUESTIONNAIRE

TECHNICIAN: ______________________________

SITE: ______________________________

Technician's Duties	Yes	No
1. How often does the technician visit the site? ______ ______________________________		
2. Does the technician park his vehicle upwind of the sampler? Does he leave it running? ______________ ______________________________	___ ___	___ ___
3. Does he check the seal on the buckets? If there are problems, how does he fix them? ______________ ______________________________ ______________________________	___	___
4. Does he check that hood delay is 1.5-2 minutes? If the delay is different what steps are taken? ______ ______________________________ ______________________________	___	___
5. Does he check inside the instrument housing? (limit switches, clutch, etc.) ______________ ______________________________ ______________________________	___	___
6. Does he check the storage gauge? (level, no debris in gauge, etc.) ______________ ______________________________	___	___

Technician's Duties	Yes	No
7. Does he check the level of all instrumentation? How often does he re-level instrumentation? (Spring only?) ________	___	___
8. Does he check the log book to ensure it is up to date and properly filled out? ________	___	___
9. Does he discuss the recent sampling period with the operator? How often does he see the operator? ________	___	___
10. Are the samples picked up directly from the operator or from a designated pickup location? ________	___	___
11. When was the last time the technician reviewed the sampling procedures with the operator? ________		
Comments: ________		

CUMMULATIVE DRY - TECHNICIAN QUESTIONNAIRE

		Yes	No
1.	How often does the technician visit the site? ______ ____		
2.	Does the technician park his vehicle upwind of the sampler? Does he leave it running?	___	___
3.	Does the technician check the rotometer setting (2ℓ/min)?	___	___
4.	Does he check for a dark ring on the rotameter flow tube?		
5.	Does he check the tubing seal on the filter pack and on the instrument?	___	___
6.	How often does he calibrate Low-Vol? ____________ ____ ____	___	___
7.	What time of year does he calibrate Low-Vol? ______ ____	___	___
8.	When was the last time he observed the operator change a filter pack? ________________ ____	___	___

CUMULATIVE WET - TECHNICIAN'S QUESTIONNAIRE

TECHNICIAN: ______________________________

SITE: ______________________________

Technician's Duties	Yes	No
1. How often does the technician visit the site? ______________		
2. Does the technician park his vehicle upwind of the sampler? Does he leave it running? ______________	___ ___	___ ___
3. Does he check the seal on the buckets? If there are problems, how does he fix them? ______________	___	___
4. Does he check that hood delay is 1.5-2 minutes? If the delay is different what steps are taken? ______________	___	___
5. Does he check inside the instrument housing? (limit switches, clutch, etc.) ______________	___	___
6. Does he check the storage gauge? (level, no debris in gauge, etc.) ______________	___	___

EVENT WET - TECHNICIAN QUESTIONNAIRE

TECHNICIAN: ______________________________

SITE: ______________________________

Technician's Duties	Yes	No
1. How often does the technician visit the site? ______ ______________________________		
2. Does the technician park his vehicle upwind of the sampler? Does he leave it running? ______ ______________________________	___	___
3. Does the technician check the Aerochem		
Sensor ______________	___	___
Gasket Integrity ______________	___	___
Gasket Cleanliness ______________	___	___
Sample bag fit in container ______________	___	___
Gasket seal ______________	___	___
On each visit? ______________	___	___
Comments: ______________________________ ______________________________		
4. How often is the operator checked for operating procedures and restrained? ______ ______________________________		
5. How are the samples transported to the laboratory from field site? (boxes, coolers with ice packs, etc.) ______ ______________________________		

EVENT WET - TECHNICIAN QUESTIONNAIRE (CONT'D)

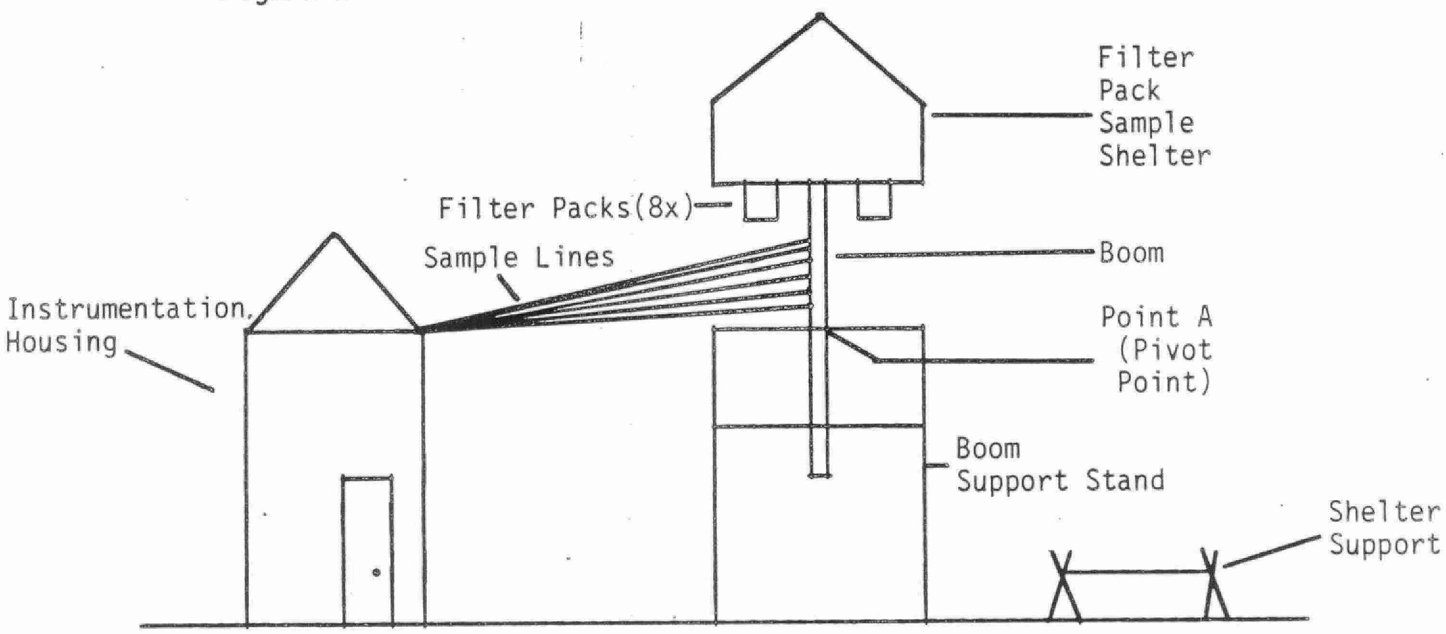
Technician's Duties	Yes	No
6. At the laboratory are the samples weighed? On what type of scale? ______	___	___
7. When is the field sample number affixed to the sample bottle? At field site, regional lab or in Toronto? ______ ______		
8. How often are supplies brought to the operators, weekly, monthly, yearly? Are they brought out on demand or according to some schedule? ______ ______		
Comments: ______ ______		

TYPE OF MONITORING - EVENT DRY

INSTRUMENT - METREX SEQUENTIAL AIR SAMPLER

Configuration Checks (Record results on "Metrex Sequential Air Sampler Data Sheet")

Figure 1



1. Are the boom and sample lines in good condition.?

2. Check to see if boom is bent especially at point A.

3. Check to see at point A if any of the tygon lines are kinked.

4. Observe flow rotameter. Is there a black ring on walls of rotameter? If yes describe ring thickness, colour (dark black, grey, brown.)

5. When the boom is lowered does it rest on any type of support keeping the Filter Pack Sample Shelter off the ground?

Calibration Checks (Record results on "Metrex Sequential Air Sampler" Data Sheet)

1. Flow - Calibration of Rotameter Check by - Turning off sequential sampler and disconnecting one suction line from back of sampler. Place 0-50 l/min mass flowmeter transducer in line and re-connect suction line. Turn sequential sampler and mass flowmeter on and allow approx. 20 min. for mass flowmeter warm-up. The output from mass flowmeter should be hooked to a digital voltmeter (scale 0-5 VDC) for most accurate reading. Using the flow controller on the sampler, perform a multi point (10 values) calibration allowing 30 seconds per reading for flow reading to stabilize. The calibration range should cover 0-25 l/min.

   Note: 1) Flow readings on the sequential may need to have a correction applied to them. This correction will be noted close to the sequential sampler flow rotameter.

   2) While performing the flow calibration separate channels should be checked for flow leakage due to sticking of values. To check this a 0-5 l/min Mass Flowmeter should be attached to each of the other ports in line to see if any flow leakage occuring while instrument flow calibration beign carried out. This flow should be monitored for a period of 5 min. and any flow noted.

2. Volumetric Counter Calibrations - The instrument set-up for calibration is the same as in the "Calibration of Rotometer" except that once the flow controller has been set to approximately 25 l/min it should not be adjusted. The sampler should run for approximately thirty minutes with each time the volume counter changes (every 10 l or approx. thirty seconds) the time and flow rate should be recorded.

3. Leak Test - This test determines whether there is any flow leakage through one sample channel while sampling is being carried out on another channel. Seven of the eight sampling ports are interconnected through a manifold which has one inlet. If any flow is to enter any of the seven sampling channels the flow must be drawn in through the one inlet on the manifold.

Procedure

1) Connect the inlet on the manifold to a flow sensitive meter (0-500 cc/min mass flowmeter is adequate).
2) Turn on the sequential sampler.
3) The sampler should be cycled so that ports not connected to the manifold are sampling. Record any flow indicating on the flow meter attached to the inlet of the manifold.
4) The sampling port should be sealed by placing a finger over the inlet and observing if there is any flow through the flowmeter attached to the manifold. (Note to prevent damage to the sampling pump the inlet should not be covered for more than 10 seconds at a time).
5) If any flow is observed the flow lines attached to the manifold should be blocked until the sampling channel that is allowing flow can be determined.

Any channel reporting leakage, should be noted on the data sheets and also reported to the regional technician so that the sampler can be repaired or replaced immediately

METREX SEQUENTIAL AIR SAMPLER DATA SHEET

Site: ____________________

Manufacturer ____________________

Model #: ____________________ Serial #: ____________________

Is the boom bent? ____________________

Sampling boom and suction lines in good condition? ____________________

____

Suction lines kinked? ____________________

Ring on Rotameter? ____________________ Thickness ____________________

Color ____________________

Support for Sample Shelter (Yes, No) _____ Channel # Flow Measured 1/min

Leak Test

Sampling Channels leaking

Rotameter Calibration Temperature ________

Reading #	Rotameter Reading 1/min	Corrected Rotameter Reading (1/min)	Voltmeter Reading (VDC)	Mass Flowmeter Reading (1/min)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Volume Counter Calibration Temperature ______

Reading #	Time (min & sec.) 1/min	Volume Reading (1 x 10)	Corrected Sequential Rotameter Reading (1/min)	Voltmeter Reading (VDC)	Mass Flowmeter Reading (1/min)
1	0'0"			0	0.0
2					
3					
4					
5					
6					
7					
8					
9					
10					

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER

OPERATOR: ______________________

SITE: ______________________

Technician/Operator's Duties	Yes	No
1. Describe operators procedures prior to lowering the boom? Does he do the following?		
- field sheet prepared for each filter pack or tower?	___	___
- are sampling channel flows transferred to data sheet?	___	___
- is the time showing on mechanical clock correct?	___	___
- is the flow rate checked?	___	___
- is the sampler turned off before the boom is lowered?	___	___
Comments: ______________________		
2. After the boom has been lowered, describe the procedure used to reload filter pack. Is the following done:		
- is a new clean sample bag used to remove filter pack?	___	___
- what type of bag is used? ______________________		
- are either the filter packs or bags labelled corresponding to sample channel? If not how are the filter packs identified? ______________________	___	___
- is the filter pack sampling for that day transferred to another sampling channel? What channel? ______________________	___	___

EVENT DRY DEPOSITION - SEQUENTIAL SAMPLER (CONT'D)

Technician/Operator's Duties	Yes	No
Yes No		
- is the sampler turned off while filter packs are being removed?	___	___
Comments: ___		
3. Describe procedure used to reload filter packs. Is the following done:		
- is the filter pack installed on tower while still in bag or is it removed by hand and then installed? ___		
- when are the sampling channels zeroed? ___		
- is the sampler restarted when the boom is on the ground or after being raised? ___		
- does the technician cycle through all channels after sampler is restarted? ___	___	___
4. What information is recorded on the sample sheets and in the site log book? ___		
5. How frequently is the sampler checked, daily, weekly? Who does the checking the technician or someone else? ___		

Technician/Operator's Duties	Yes	No
6. At the laboratory how long do the filter packs usually sit before being unloaded? ______________________		
7. Does the technician unload filter packs in a:		
- laminar flow chamber?	___	___
- fume hood?	___	___
- office?	___	___
- laboratory?	___	___
8. Are thre any exposed contaminants in filter processing area?		
- anyone smoking nearby? ______________________	___	___
- any exposed chemicals - especially H_2SO_4 or HNO_3 ______________________	___	___
- is the area generally clean or dirty? ______________________	___	___
Comments: ______________________		
9. What kind of work surface does the technician use?		
- teflon coated table top?	___	___
- lab bench?	___	___
- lab bench with plastic on top?	___	___
- office desk?	___	___
Comments: ______________________		

Technican/Operator's Duties	Yes	No
10. Is the technician's system for labelling bags easily understandable and logical? (describe the system used)	___	___
- is it done all at once prior to unloading any filter pack?________________	___	___
- is it done as filter packs are unloaded?________ ________________	___	___
Comments: ________________ ________________ ________________		
11. Describe the procedure used for handling the filters? Are the following points observed?		
- are teflon tweezers used for filter handling?	___	___
- are tweezers stored in methanol prior to use?	___	___
- are they wiped with new Kimwipe before touching filters?	___	___
- are separate tweezers used for impregnated and unimpregnated filters?	___	___
- are Nylon and Impregnated W41 filters folded twice before placement in sample bags?	___	___
- are gloves worn during filter pack unloading?	___	___
Comments: ________________ ________________ ________________		
12. Describe the procedure used for the washing and drying of filters? Is the following done:		
- where are filter samples stored after unloading from filter packs?________________ ________________		

Technican/Operator's Duties	Yes	No
- are filter packs completely disassembled prior to washing?	___	___
- are the filter packs rinsed after washing? What rinses are used? ______________________	___	___
- how many of each type of rinse are performed? ___ ______________________		
- how are the filter packs dried? If air dried, are they covered during drying? What covering is used? ______________________		
- if dried in an oven, how long, what oven temperature? ______________________		
- are the filter packs used after drying? If not, how are they stored? ______________________	___	___
Comments: ______________________		
13. Describe the procedure used for reloading of filter packs. Is the following done:		
- does the technician clean off the area where filter packs will be loaded?	___	___

Technican/Operator's Duties	Yes	No
- is the work surface a lab bench, Teflon overlay board, "Kimwipes" over lab bench or other area? ______		
- are cleaned tweezers kept in separate breakers - one for unimpregnated and one for impregnated filters?	___	___
- when removing filters from bag does technician push his hand into bag or only tweezers? ______		
- when placing collar on filter pack is technician careful not to get hand near open exposed face of filter?	___	___
- is the inlet of the filter pack checked to ensure the O-ring has not failed?	___	___
- is the loaded filter pack numbered and stored in a new "Zip-lock" or "Whirl-pak" bag? ______	___	___
- how are loaded and bagged filter packs stored prior to shipment to field? ______		
Comments: ______		
14. Are any of the filters from Toronto ever damaged? (i.e. nicks out of the sides). If so what is done with them? ______	___	___

FALL 1983

SITES VISITED DURING PHASE I AUDIT

(Sites are shown in the order audited)

	SITE	TYPE
1.	Longwoods	Event
2.	Alvinston	Cumulative
3.	Melbourne	Event
4.	Mattawa	Cumulative
5.	Azure Lake	Cumulative
6.	Moonbeam	Cumulative
7.	Nithgrove	Event
8.	Campbellford	Cumulative
9.	Graham Lake	Event
10.	Golden Lake	Cumulative
11.	Colchester	Cumulative
12.	Shallow Lake	Cumulative
13.	McKellar	Cumulative

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